3rd Postgraduate Conference 2005
Construction Industry Development
Johannesburg, South Africa
9-11 October 2005
ISBN 0-621-36321-9
pp.373-388

A COST MODELLING DESIGN STRATEGY FOR DWELLER-INITIATED TRANSFORMATIONS IN URBAN HOUSING

Makachia P.A.[1], Talukhaba A.A.[2] and Omenya O[3]

[1]*Department of Architecture, University of Nairobi, PO Box 30197, Kenya*
[2] *School of Construction Economics and Management, University of the Witwatersrand,PO Box 20, Wits 2050, South Africa*
[3]*School of Architecture and Planning, University of the Witwatersrand, PO Box 20, Wits 2050, South Africa*

Geometric manipulations of the basic spaces and the relationship to services govern architects design strategies towards affordable housing. This cost control also entails the choice of low materials' specification and processes that are employed in construction. Inadequate attention is paid to financial models that encapsulate flexibility as in dweller-initiated transformations. In an empirical study carried out in Nairobi's Eastlands residential zone, the propensity for dweller-initiated transformation and the dweller-ship modes that govern them were established. The predominant occupancy modes were sub-letting in these council rental units. To capture and positively cultivate these phenomena, a densification proposal through tenant empowerment using flexible financial, ownership and technical frameworks is proposed. This is developed in a spreadsheet-based, market sensitive, flexible financial model for the low-income. It will be useful in investment projections for the dweller as well as community actors like housing cooperatives, NGOs and CBOs. Specifically small and microfinance institutions (MFIs) and housing cooperatives will find the model useful in investment priorities in incremental housing.

Keywords: Design, flexibility, housing, modelling, transformation.

INTRODUCTION

The architect's approach to a low-income housing strategy is largely premised in spatial configurational explorations. This entails manipulating the design form to reach an optimum geometrical configuration that meets the target group affordability. As a strategy, this approach implies that one has to optimise the spatial articulations and tally with the function to attain a cost effective relationship. Whereas this is only but a logical direction given the professional biases of the architect, it de-emphasises process-based and financial dynamics that govern dweller-initiated transformations.

Transformations are understood as modifications, firstly, of the existing design product by the expansion of plinth area, addition of spaces laterally and vertically, or by adding spatial units like rooms, alcoves, corridors, etc... Secondly, transformation is viewed as qualitatively re-organizing the disposition of the provided spaces, through

relocating, resizing of openings between spaces and /or to the exterior environment. Indeed, in Kenya these transformations are grudgingly being recognised as an alternative mode of producing affordable housing, in the context of diminished formal production by the state and other formal institutions.

Configurational manipulations can therefore be more complete if they encompass the dynamics of dweller investment in a projected additional spatial unit and returns from its subletting and other incomes such spaces may generate. Typical configurational optimisation studies for affordable housing (and indeed other building types) result in minimising the surface area in relation to the plinth area in a theoretical study (De Troyer 1994 & 2005). The result is inevitably often a square plan-form and in the third dimension, a cuboidal form. Practically this is somewhat manifest, for instance, by use of shallow roofs in places where the slope's functional requirement is but to drain rainwater. Another application of the configurational strategy involves grouping of housing units. The grouping as in apartment blocks largely saves on land acreage and in the sharing of services. Other grouping strategies are as in the courtyard typology used in some estates like Umoja II condominiums (Tuts 1984).The form aspects also consider material specifications in defining the building elements and components. In specifying materials their import-content is investigated to mitigate the impact of the largely debilitating global capitalist forces. These and other cost alleviation measures are typified by research findings[1] and application in housing estates[2]. At planning level, cost minimisation includes plot-form configuration (narrow frontage in relation to plot length), sharing and grouping of services, especially engineering infrastructure (roads, paths, waterlines and sewers). The technology choice optimises between locally available labour and capital-intensive import-based machine technology (Reutersward 1984). The competing paradigms of self-help and contractor-built processes are also considered in a housing design (Erkelens 1991).

In dweller-initiated transformations, the stated cost control measures are relevant but assume less significance at this secondary and tertiary development stage to the extent that the dweller prioritises expenditure to mimic the returns from the transformation costs. Indeed form considerations are as relevant, but only insofar as they enable the self-developer attract tenants paying commensurate rent. Planning cost considerations are also of little consequence at the plot level as this is predetermined by the existing building and planning fabric[3]. The technology entails self-help processes; mainly self-management using labour contracts and material production mechanisms (Erkelens 1991) but hardly self-building[4].

In the empirical investigation, the physical transformation was observed for its frequency, technology and magnitude. Its function reflecting not only the driving forces behind the user action, but also the rental returns (based on average rents for size of the space and activity it was used for) were collected. Selection of the sample units was preceded by a desk analysis of the site planning layouts to choose units based on location in relation to arteries of circulation as well common public spaces. The location of the transformation unit and its function were collated and interpreted as a covert 'physical trace'[5] of the implicit design intention by the dweller. Though

[1] for instance studies in alternative building materials like Stabilized Soil Blocks (SSB) and Fibre- Concrete Roofing (FCR) tiles and sheets by the University of Nairobi and building standards (Agevi 1992: 8)
[2] e.g. 'starter' units (Makachia 1995)
[3] Stress on infrastructural is often the basis for negative attitudes to DIT. A services upgrading process should therefore an added consideration by the local authority to make DITs more environmentally sustainable.
[4] based on findings in informal settlements (Syagga & Malombe1994)
[5] in line with Zeisel (1980) on enquiry by design methods

counting the activities was enumerated. Measurements and sketching were to further establish the magnitude of the phenomenon. A documentation of the technology was done through observation, paper ad digital photographs.

A broader survey in Eastlands' estates Nairobi (where the case study of Ofafa Maringo estate is located), a low-income City Council residential zone entailed establishing the prevalence of the transformation phenomenon and their use and propensity for subletting. While these phenomena were confirmed, it was also discovered that even the original units were also partially sublet on room by room basis allowing for shared services' spaces. The 'sub'-rents paid by the 'lodgers' covered the remission to the Council and additional income to the tenant. Further, additional non-residential functions were observed and these included; light industrial activities like timber and metal ('jua kali') artefact fabrication, as well as petty trading in grocery kiosks, hair saloons and barbers among others. These contributed additional income to the tenants that would profit future investment in additional dweller-initiated transformations[6].

It was evident that despite the lack of tenurial security, the dwellers assumed territoriality over adjacent space which they proceeded to appropriate for their transformation activities. Corner units, for instance often fenced off this space and used it for a variety of activities including crop farming and rearing of domestic animals for subsistence. It was noteworthy that the materials used for erection of the units were temporary (corrugated galvanised iron (GCI) sheets and timber off cuts on walls), reflecting the insecurity emanating from the rental mode of units' occupancy and habitation.

The paper does not delve into the details of the transformation phenomenon[7] but instead proposes a financial model that can be useful in simulating scenarios for expansion. It assumes dweller-empowerment through ownership tenure rights of the currently rented units.

As a background to the Eastlands' estates it should be stated that the projects developed in the colonial era to house Africans were based on the spacious 'garden city' neighbourhood unit concept (NUC) in the master plan for Nairobi (MP) by Thornton White et al (1948). The rapid growth of the city has engulfed the once peripheral location and is of now considered prime land given its close proximity to the central business district (CBD) and the industrial area; the two major employment and commercial loci of Nairobi. Proposals have been floated at various times by the Nairobi city council (NCC), the National Housing Corporation (NHC)[8], academic institutions (PGCHS 1993) and external business concerns for the redevelopment of the estates but none have yet to bear fruits. Most of these plans envisage demolitions, mass developing of apartment blocks with minimal involvement of the sitting tenants. The paper assumes new social and legal structures (also discussed in a manual presented at San Jose, Costa Rica (Makachia 2005)).

The use of the Ofafa Jericho estate and unit typology (fig.1 & 2), as a technical proposal, is only an illustration that can be elaborated differently in other estates in Eastlands.

---

[6] This echoes findings in Addis Ababa by Tarekegn (2002) where additional spaces are used for income generating.

[7] Tipple (1991 & 2000) looks at motivators for dweller-initiated transformation in public housing and these include economic and social factors. Nguluma (2003) investigates the same but in informal settlements in Dar es Salaam which she records as 'modernisation' additional to economic factors.

[8] NHC is a parastatal corporation charged with developing public housing in urban areas and also supports housing in rural areas in Kenya.

FINDINGS & DISCUSSION

Background: Ofafa Maringo Estate

Ofafa Maringo estate, developed by the Nairobi City Council in 1956, has a density of 52 units per hectare composed of 1400 units grouped in single-storeyed blocks of 8 units (fig.1). This low density was in line with Neighbourhood Unit Concept (NUC) developed in the MP. The open spaces are poorly defined leaving vague conceptions of territoriality by the dwellers and seemingly contribute to the prevailing poor neighbourhood security. Large parts of these spaces have been (mis-) appropriated for agricultural activities like crop and domestic animal husbandry.

Basic infrastructural services including water, tar marked roads, electricity and street lighting, sewerage, storm water drainage and garbage disposal were provided. They are however in poor maintenance state due to chronic perennial institutional management shortcomings at NCC. Social infrastructure, in line with the self-sufficiency concept entailed in the neighbourhoods proposed in the MP, is provided and includes a commercial centre, a playfield, health centre and religious worship places. Though not a priority[9] at conception in the MP, educational amenities including primary schools and a library are available. Most of these social amenities are however in poor management and physical state. This naturally is a pointer to the

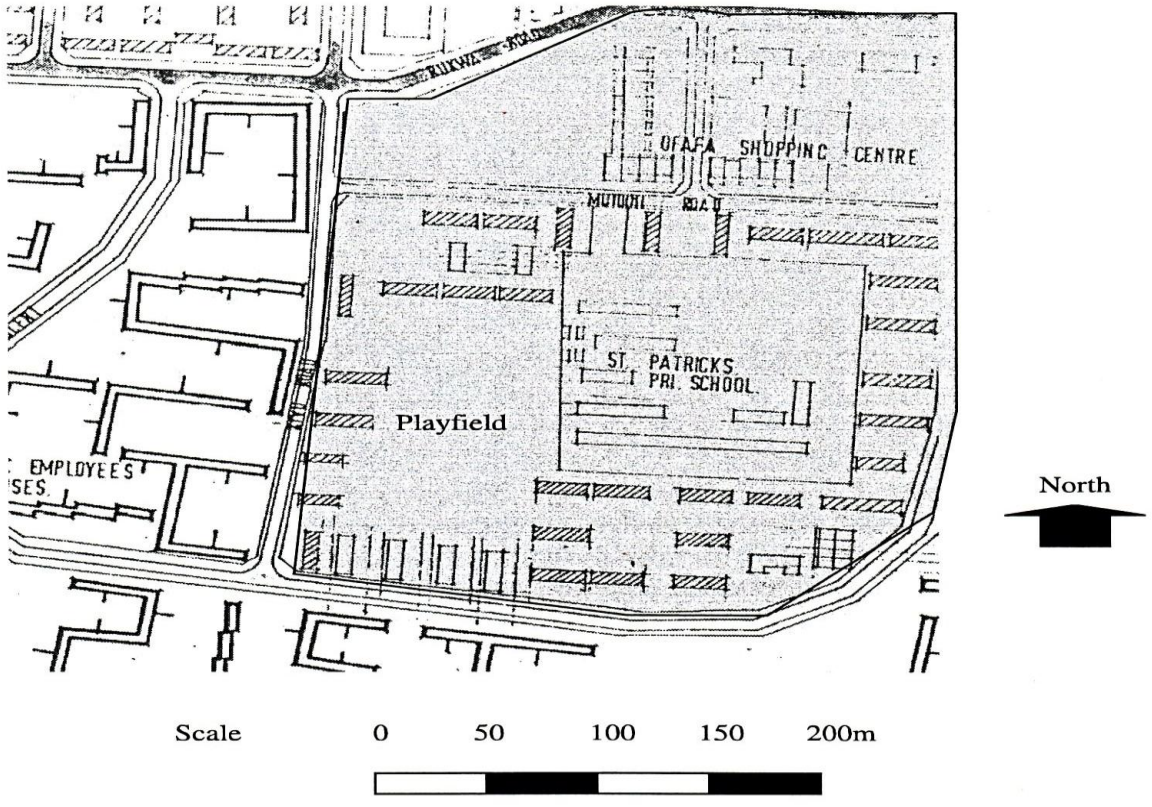

Figure 1: Site plan -Ofafa Maringo

ineptitude of NCC but more fundamentally the absence of a grassroots' housing community self-organising structure. For instance, unplanned kiosks mushroom on the road reserves and around the shopping centre; another facet of the failed council and the absence of an alternative community structure.

Each unit is one bed-roomed of $32m^2$ in area meant for a single family occupation. The units on the upper are accessed in opposite direction from those on the ground, giving the unit a rather ambiguous orientation (fig.2). The blocks are constructed using conventional masonry-based materials for walls (concrete blocks painted

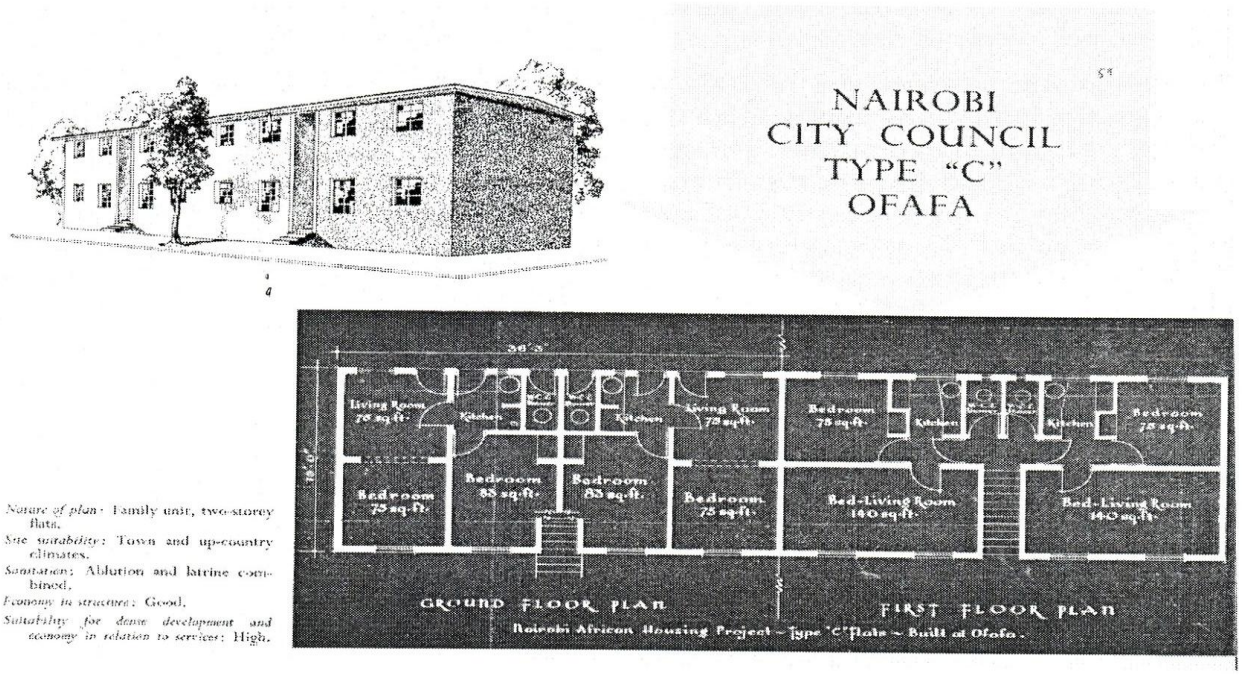

Figure 2: Unit- 3-d Block and Plan

internally and externally), reinforced concrete floors and ring beams, shallow sloped (5^0) asbestos sheeting for roofs, steel casement windows and wooden doors. Windows have been transformed by addition of burglar-proofing steel grills. They remain in good structural condition but most are in poor decorative state.

Dweller-initiated unit transformations in Ofafa Maringo estate

The prevalence of transformations in Maringo was high and occurred on the access pathways or the main road. Nearly all (90%) on the major access roads had an extension. On the inner paths, there were fewer (40%). The functions accommodated reflected the location in relation to the pathway.

Thus transformations on the main roads were predominantly of a commercial nature; mainly kiosk cafeterias, grocers and green grocers. Other activities were hair saloons, pay-telephone booths and timber furniture workshops. Residential extensions were mainly on the inner locations and closer to the entrances of the units; presumably due

[9] The MP did not recognize a primary school as a desirable part of the NUC in the belief that education was not central an African community formation (Emig & Ismail 1980)

to privacy and the nature of the occupants. The occupants were mainly members of the household. Seemingly the transformations were for income generation or could be used by a member of the household or a lodger for the same objective. Residential extensions were for the house hold[10], to cater for increased family needs and privacy.

Other significant locational aspects included proximity and magnitude of adjacent public space like road and other services' reserves. Corner units benefited most by appropriating this enlarged adjacent space and used it for mainly commercial functions. It should be stated that transformations occurred in spaces that the dwellers felt sufficiently in control. Thus, they avoided conflict with the neighbours' domain but were not averse to risks with regard to public space[11].

The initial study carried out in 2002 showed more (65%) extensions than reported above in the inner units, but political action to demolish these extensions resulted in the reported reduction (to 40%). The commercial extensions were least affected by the demolitions because they posses business licences not possible for residential units. The reported re-birth of the extensions reflected the dwellers' felt need and determination to defy authorities to fulfil their habitation ambitions and needs. Other significant extensions after the demolitions were boundary defining elements. The instructions were erect them to a 1metre height with opaque material, mainly Corrugated iron sheeting or timber. Beyond this height barbed wire was allowed to address the security concern.

The dweller-initiated transformations were erected predominantly (95%) from 'temporary'[12] materials like timber off-cuts and iron sheeting for walling on a wood or timber poles' frame. The floors were before demolitions and remain from cement-based (albeit without walling!). The otherwise 'temporary' technology is therefore transitory probably reflecting the lack of tenurial security.

Their spatial aspects however reflected the felt habitation demands. Each unit extended easily accommodated two rooms of lengths between three (3) to four (4) metres. The plinth areas range between ten (10) and twelve (12) square metres[13]. These extensions encroach on open spaces at the entrances to each unit. Undoubtedly this limited play areas for children, access passages and footpaths. The remainder of the open space was used for drying laundry; another function ill-provided for.

The occupancy situations reflect the predominance of subletting in the main house. This house is leased directly from NCC at about 1200 Kenya shillings but is sublet as complete ('full house') or as rooms, accommodating at least two households. The smaller room attracts rents of between 400 and 600 Shillings while the bigger ('double room') goes for between 600 and 1000 shillings. The units were designed for bachelor accommodation (Nevanlinna 1996) (Emig & Ismail 1980) (Stren 1978) but have since assumed this multi-household occupation, congesting and aggravating the over-crowding situation.

On average there is overcrowding within the units with densities of 2.5 square metres per person, below the minimum acceptable standard of 3.5 square metres. At the planning level, the planned density of 42 units per hectare for the estate was low for

[10] In most of these Eastlands' estates, a 'de factor' generational tenancy inheritance exists whereby the books at City Hall reflect the original tenant while the actual occupancy has perennially been changing hands along these sibling generations.
[11] This corresponds to the position that government was ineffective in controlling development by commission (corruptly permitting such developments) or omission (ineptitude).
[12] 'temporary', here is a common euphemism for materials not recognised by the Building Code (1997) and reflect non-durable and easily deconstructed materials like wood, paper, sheeting materials for walling
[13] Measurements before demolitions and taken from the cemented plinth still evident.

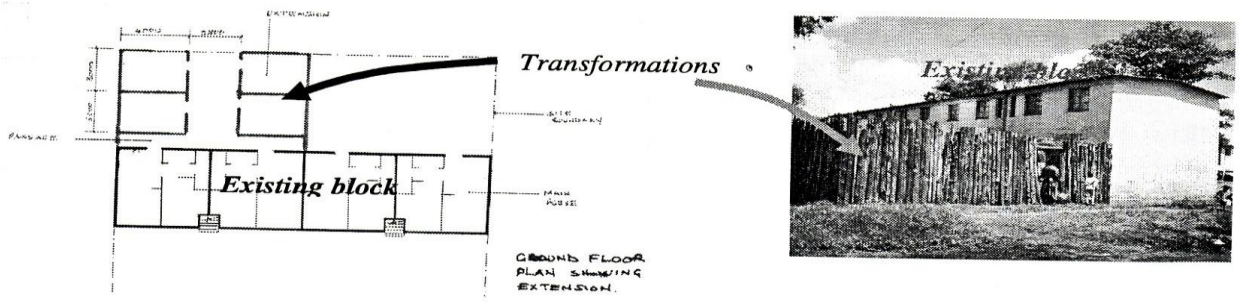

Figure 3: Temporary transformations

the high density settlement that the estate is now categorised. This is more so given the estate's close proximity to the CBD (about five kilometres) and indicates that the land has been less than optimally utilised. These findings point to the need to densify the estates to accommodate the unmet demand for affordable housing and exploit the proximity to the CBD. Such a strategy should however not ignore the sitting tenants. To make the sitting tenants responsible to their environmental context, a community and individual empowerment framework be enabled through tenure rights.

DENSIFICATION PROPOSAL

The objectives for the densification proposal are four: legal, social, technical and financial tenant empowerment in Ofafa Maringo estate as elaborated below.

Legal empowerment

Legal empowerment is through transferring ownership and thus tenure rights to the sitting tenants. It is felt that this will enable them take more responsibility for physical and social environmental quality. It also gives them the confidence in investing in their homes. Two legal structures and instruments could be adopted in the proposed dispensation. These are The Sectional Properties Act (1987) and housing cooperatives.

The Sectional Properties Act (1987) that facilitates common ownership of a building block (apartment block, condominiums or indeed any two or more 'conjoined' building units) will be the guiding legal frame[14] for covenants for individual and communal rights and responsibility. The stipulates individual ownership of a unit coupled with common ownership of the land on which the block stands as well as common spaces and parts of the entire building like staircases. The dwellers operate as tenants in common to these commonly owned spaces. The sale of any unit by dwellers, who are conjoined in a 'corporation' for the block, is not restricted as in a cooperative housing alternative. The Act does not restrict individual proprietors from owning multiple units at any stage in the life cycle of the building. The use is also not restricted. In the proposed structure, this may have to be amended by members so as permit the membership to veto such functions they feel not conducive to common good.

Another legal structure proposed would borrow from the housing cooperative modes ownership. In Kenya, NACHU (National Housing Cooperative Union) an umbrella organ charged with offering technical services and coordinating shelter issues to

[14] Others include Norwegian Joint Ownership Act (Nordic Council of Ministers: 1998) and the structures in cooperative housing in South Africa (Sommerfield: 2001)

housing cooperatives and other deserving causes would feature prominently. Registered under Cooperative Societies Act (Cap 490), NACHU would aid in coordinating cooperative practices in the proposed structures. These include control of transfer of the unit. Here, a right of pre-emption would be enacted by members and enforced so that transfer of the unit should be subject to other society members having the first right of refusal before outsiders can be offered the unit for sale and transfer. A restriction to the number of owned units and their use by member would be clearly stipulated unlike the Sectional Act discussed above. Details of such modes ownership are discussed here.

Social organisation

These legal rights also mean a more accountable community organisation can be facilitated. Thus the second objective is to create *social organisational* structure that assume responsibility over the environment and make democratic community decisions and actions. It will assume a legal entity that vouches for common decisions and actions. The scales will be hierarchical reflecting spatial organisational entities ranging from the block, the cluster, street up to the entire estate. These Residents Associations (RAs) will also have some budgetary control in management of common spaces, services and facilities. The legal instruments proposed above stipulate the legal identity such organisations would conform. Thus the 'corporation' in Sectional Act and Housing Cooperatives would be the starting point of such social structures[15].

Technical framework

The technical proposal assumes the legal and social frameworks mentioned are operational and relies on covenants that facilitate the administration of common and boundary areas. The technical framework thus defines the extents through cadastral and topographical survey of individual and shared spaces and service lines. Central to the spatio-technical framework are:

- The *incremental* nature (fig.4) of the designed unit, allowing for progressive dweller-initiated transformation. This is achieved at both spatial as well as structural level using a reinforced concrete structural frame.

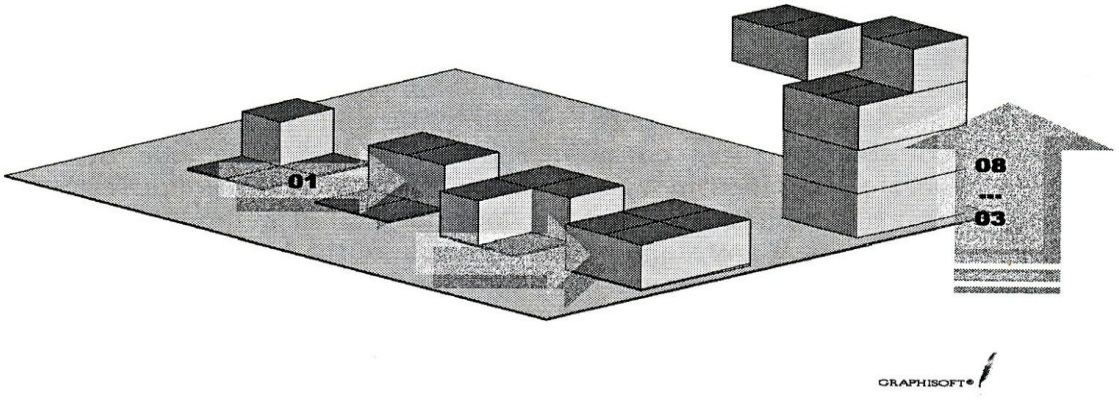

Figure 4: Phasing scheme

[15] An elaborate compilation of manuals borrowed from South Africa by Cope Housing Association by Sommerfield (2001) guiding use, management and other rules may be referred to, for such guidance.

- *Flexibility* in the incremental options (fig.5, 6). This is achieved through a definition of the structural frame that permits partitions using permanent or temporary materials. The minimum spatial entity is a unit adequate for subletting. This can be a single room expandable to two or more units depending on the rental type in current demand and subject to market forces.

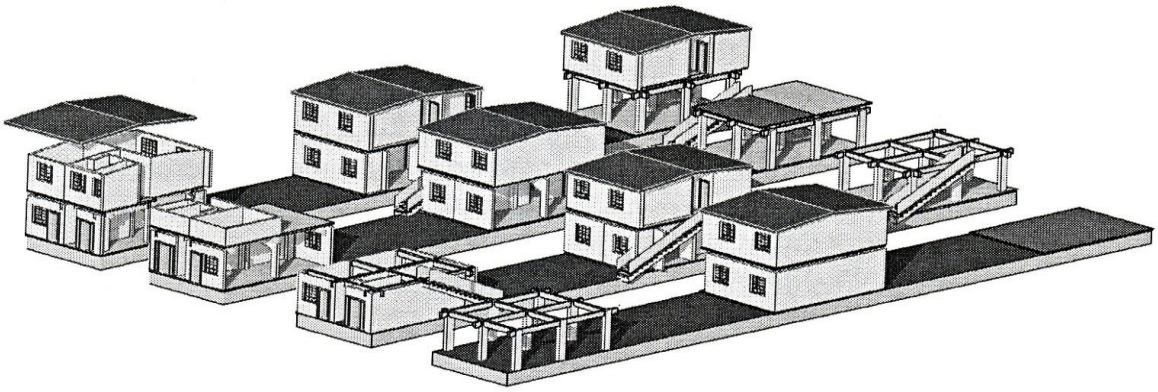

Figure 5: 3-d transformation scenarios

- The *service core* incorporating the 'wet areas' of water closet (wc), shower, splash area and kitchen sink are developed to be shared on the each storey level regardless of the number of the units and households inhabiting the floor. The first phase unit is therefore strategically located to house these amenities. It is costs are eventually spread out on the entire floor.
- The *vertical circulation* through a staircase that is allowed for in the spatial disposition and allowing for access to the next level. It is completed at commencement of the next level. The cost is spread over the floor units and progressively to subsequent units above.
- The *foundation and roofing* costs are initially borne by the first units and eventually spread over the entire consolidated block.

These extents are in turn guided by the relevant statutes that also stipulate financial responsibilities.

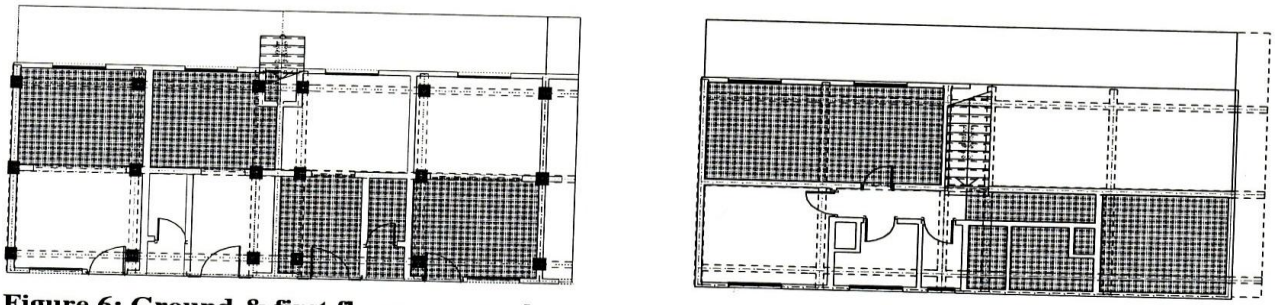

Figure 6: Ground & first floors proposals –part plans

The financial framework

This aims to enable an economically sustainable dwellership by the empowered tenants. This is achieved through facilitating access to finance and recognising subletting by the tenants. This entails the model hereby elaborated which simulates financial scenarios illustrating viability of the investment in the units. The paper is focused on to this financial model detailed forthwith.

THE MODEL

The rapid growth in housing demand in poor countries like Kenya has stressed the public coffers to the extent that small-scale financial institutions and individuals have to assume financial responsibility in developing appropriate housing as in dweller-initiated densification of the few formally developed estates. The model developed here assumes informal and small-scale dweller-initiated systems that mobilise informal savings, incremental growth, subletting and re-investing in the provided housing unit. It presumes that human settlement professional cadre (architects, urban designers, construction managers ...), developers (financiers), civic organisations (NGOs, CBOs and Residents' Associations (RAs)) and policy makers will find a relevant niche. The inputs presume a stable or predictable market and do not engage in the evolution of the financial, cost and other economic variables. These include macro-economic forecasts, the specific householder and project technical economic and cost parameters; now described. The Excel© spreadsheet model developed by Prof. De Troyer (1994, 2004) of Catholic University Leuven (KUL) is used in assessing time and cost factors in incremental urban projects. The inputs (Table 1) thus include economic forecasts, financial and technical transformation cost parameters explained below.

Table 1: Input parameters

Economic forecasts			
Yearly		Monthly	
Income (I)	252,000	Income (I)	21,000
fraction (f)	20.0%	fraction (f)	20%
Growth rate income (g_i)	5.0%	Growth rate (g_i)	0.41%
Growth rate constr cost (g_c)	8.0%	Growth rate (g_c)	0.64%
Growth rate subletting (g_{sl})	4.0%	Growth rate subletting (g_{sl})	0.33%

Financial parameters			
Yearly		Monthly	
Interest rate saving (r_{sav})	10.0%	Interest rate (r_{sav})	0.80%
Interest rate borrowing (r_b)	12.0%	Interest rate (r_b)	0.95%
Period of loan (n_b)	3	Period of borrowing (n_b)	36

Technical parameters of expandable type				
	Possible start subletting (month)	Last month of subletting	Costs now	Rent now/period
Phase 1	1	251	250,000	3,125
Phase 2	1	251	250,000	3,125
Phase 3	1	251	250,000	3,125
Phase 4	1	251	250,000	3,125
Phase 5	1	251	250,000	3,125
Phase 6	1	251	250,000	3,125
Phase 7	1	251	250,000	3,125
Phase 8	1	251	250,000	3,125

Market parameters

Income of the target group "I" is notoriously difficult to determine in most poor communities as they engage in unrecorded economic activities that escape documentation and are mostly unpredictable. In model an arbitrary figure of KShs.

21,000 is used to include a minimum formal salary and incomes from other unrecorded sources, typical of a poor household in Nairobi. The model uses the monthly income but if annual figure is known it can be inserted to be computed monthly. The fraction "f " reflects a fraction of the income that can be saved for construction of the extension. Most conventional rent computations use 20% of the income but households investing in their own house are known to devote even more than the 35% used in the model. The growth of Income "g_i" is a rather optimistic view but some households do expect things to get better. The low figure of 5% used reflects the cynical position. Construction cost Growth rate "g_c" assumes a stable market and is viewed as close to the general inflation. Actual figures are not normally generated by the bureau of statistics. Rental Income growth rate "g_{si}" reflects subletting rent increase that can be computed over longer (than a few years) periods. Constant annual increase in rents is hard to sustain particularly for the low income tenants[16].

Financial parameters

The cost of money is the main concern in this part of the model. In addition to the banks and financial institutions, parallel microfinance institutions (MFI) are increasingly available, offering sustainable financial alternatives (Sabana: 2005). For instance microcredit for housing finance (MCHF) for home improvement and repair loan could be deployed for house transformation. Flexibility would be required to tally normal repayment periods, normally 6-12 months (Sabana: 2005) with transformation periods and accumulated savings. Such loans rely on group liability to deter delinquency rather than normal collateral.

In addition, informal systems exist where social groups rotate small but significant loans to members (e.g. women 'merry-go-round'). These however are exceedingly expensive (between 10-30% monthly repayments) and involve shorter repayment periods (months). Indeed they rely more on mutual trust than economic sense. They involve high risks as no collateral securities are formally demanded and are not recognised by the state. Other sources of money include (Savings and Credit Cooperative Organisations) SACCOs and housing Cooperatives. The inputs in the model include: Savings Interest rate "r_{sav}", Borrowing interest rate "r_{sav}" and the period of repayment "n_b".

Transformation parameters

Transformation parameters include: its *cost* and *rent* it attracts. It is assumed that the unit attracts rent or a saving in rent paid elsewhere in case the householder leases alternative accommodation in lieu of the space they currently occupy. The model requires one to specify when it will be available for subletting, which assumed to be immediately it is completed. It also demands when the subletting stops (which is assumed infinity, but a large figure 251 (taken as a 20 years lifespan of the unit!). The cost of the unit based on an estimate of square meter rate of conventional construction but adjusted to allow for self-help construction, production and management, typical in dweller-initiated development. It allows for specific phase details like when a service core or staircase is constructed (as this implies higher unit rate). Indeed unit construction rates assume larger scale constructions and therefore may not factor in peculiarities of small scale development, like wastage and any savings due to self-management.

[16] Changes in rents are often resisted by both parties and are only assured if there is a change of tenants.

SIMULATION RESULTS

The four scenarios investigated demonstrate the potential of modelling the dweller's financial options in the transformation of the housing unit. In first scenario, it is assumed the dweller is only developing for the households use and without borrowing development finance. The second option allows for subletting of the unit, while the third alternative gives to financial support as a loan. Finally, all the above options allowing for transformation capital from savings, subletting rents and loans, are incorporated. The following are scrutinised; (i) the earliest time of completion of a unit, (ii) the frequency of additions and (iii) the final consolidation date of the apartment.

Scenario 1: Savings only

Relying on savings alone for the target income group, would result in the first transformation unit only after more than five years (62 months). Further additions also can only be possible beyond five years; 11 years and 18 years respectively (average six years; Table 1).Using the given market and householder economic conditions, it is impossible to undertake further transformation units beyond these three within the targeted twenty year life of the unit. A household that envisages their spatial requirements will be met only with the three spatial units, at the six-year interval and over the long period of eighteen years will be satisfied with this scenario.

Table 2: Transformation periods with savings only

Transformation unit	1	2	3	4	5	6	7	8
Period in mont	62	132	216	#N/A	#N/A	#N/A	#N/A	#N/A
Period in years	5.2	11.0	18.0	#N/A	#N/A	#N/A	#N/A	#N/A
interval in year		5.8	7.0	#N/A	#N/A	#N/A	#N/A	#N/A

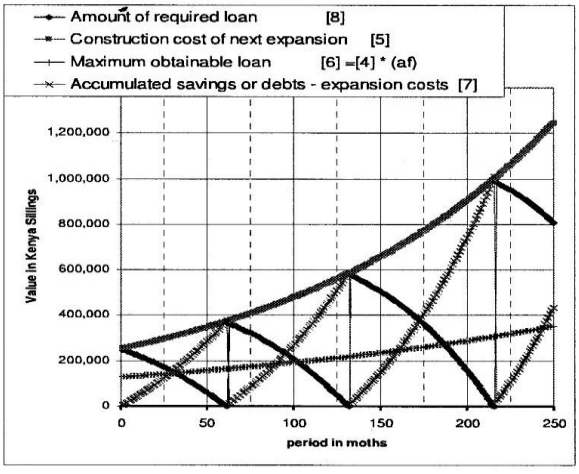

Figure 7: transformation through savings only

In reality households may be driven into faster transformation through both intrinsic and external forces (Seek 1983),) like added income or changed market conditions. Intrinsic forces may also include socially driven ones like an expanded household (more children) and / or changed structure (older, more independent offsprings). This may entail a higher amount and / or proportion of income devoted towards dwelling transformation. The model aids in determining desirable aspects of both income and proportion, as well as their timing, that can be channelled towards the expansion. For the policy maker it entails adjusting macro-economic parameters like lowering interests on savings. It may involve controlling of construction costs of materials thus reducing import content. The model also illustrates the maximum obtainable loan which is investigated in the next scenario.

Scenario 2: Savings and loans

If the dweller chooses to borrow for transformation, the completion of the first unit would occur faster (in two and half years) but subsequent units will take longer (6 and seven years respectively) (Table 2). Further, the unit may still not be transformed beyond the third unit. The third transformation occurs earlier than without borrowing by nearly two years. It is apparent that borrowing alone does not spur transformation activity sufficiently to be worthwhile. Indeed, it is a reflection of the need to view low-income housing more for its income-generative value, investigated in the next scenario. As in the above the decision to add the new space earlier is determined by the specific conditions prevailing in the household and macro-economic forces. As such the decision to borrow would be in line with the perceived spatial needs by the household.

Table 3: Consolidation periods for savings and loans

Transformation unit	1	2	3	4	5	6	7	8
Period in months	32	108	199	#N/A	#N/A	#N/A	#N/A	#N/A
Period in years	2.7	9.0	16.6	#N/A	#N/A	#N/A	#N/A	#N/A
interval in year	6.3	7.6	#N/A	#N/A	#N/A	#N/A	#N/A	

Scenario 3: Savings and Subletting only

The subletting option immediately avails more capital towards transformation as can be seen with the frequency of additions, every two years averagely (Table 4). As expected, the first unit can only be possible after sufficient savings have been made as was in Scenario 1. It is also now possible to consolidate the apartment block to the maximum eight units.

Table 4: Savings with subletting transformation option

Transformation unit	1	2	3	4	5	6	7	8
Period in months	62	103	135	163	187	209	230	249
Period in years	5.2	8.6	11.3	13.6	15.6	17.4	19.2	20.8
interval in year	3.4	2.7	2.3	2.0	1.8	1.8	1.6	

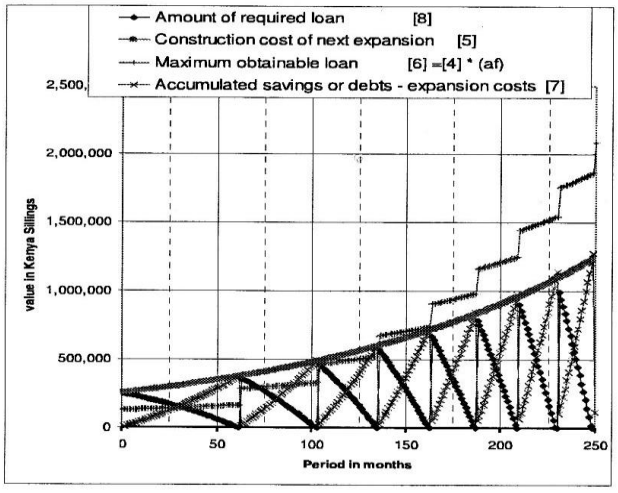

Figure 8: Transformation with subletting and savings only

The graph below (fig.8) graphically illustrates the scenario. It should also be noted that because of the subletting the access to a loan and the corresponding maximum value is magnified. The decision to sublet therefore situates the modest income earner firmly in market economy and promotes housing production that suits all.

The model enables one to determine the appropriate loan towards transformation and the timing, best illustrated in scenario 4. The typology proposed promotes uniform spatial additions, a situation that is not always followed by dwellers. For financial planning purposes this provides a guide to a negotiated framework for the dweller. The next section illustrates the scenario where a loan is incorporated to reinforce the transformation potential.

Scenario 4: savings, loan and subletting options

Reasons for needing a loan include speeding up the consolidation process. It is possible to convince investors through this computation that low income housing is a worthy investment opportunity. The results from the model indicate speedier addition for the first unit (32 months) and at higher frequency for the others (averagely two years) (table 5). The block is fully consolidated after less than fifteen years.

Table 5 savings, subletting and borrowing consolidation options

Transformation unit	1	2	3	4	5	6	7	8
Period in months	32	60	83	102	119	145	163	179
Period in years	2.7	5.0	6.9	8.5	9.9	12.1	13.6	14.9
interval in year		2.3	1.9	1.6	1.4	2.2	1.5	1.3

The scenario however exposes the dweller to market vulnerability due to higher indebtedness and a situation which risk-averse investors may not welcome. This is a situation suited for those in housing as a business. Housing cooperatives can mobilise members to participate in owning and investing in existing estates for densification by providing loans. Subletting speeds up repayment of loans enabling the faster consolidation for apartment blocks. The housing cooperatives are more likely to offer housing loans that attract social interest rates, below the market condition to its members. The model therefore facilitates monitoring of the loan money and the cooperative developer can employ for the same.

CONCLUSIONS

The four scenarios investigated are summarised in figure 9 below.

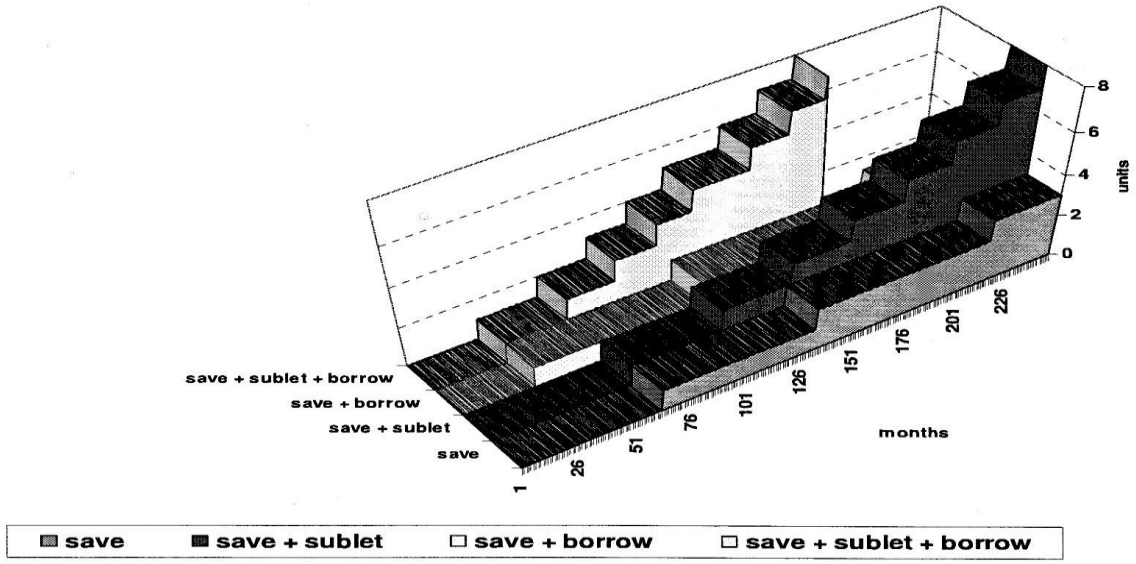

Figure 9: comparison of the consolidation scenarios-3-d histogram

The comparison illustrates that with subletting, regular and periodic additions are guaranteed. Further the completion of the block is possible. This is a situation which cannot be envisaged using any other mode. The savings for the low income are small and cannot in themselves ensure complete consolidation of the unit. A loan coupled with subletting speeds up the process. Borrowing alone can be useful if the terms and conditionalities, including interest rates and repayment period, are controlled. The

loan however speeds up the commencement for the first transformation unit. These simulations can therefore be used in influencing policy decisions as well as housing finance institutions in shaping their loan for housing portfolio. More realistically, community based organisations (CBOs) with seed finance from an NGO can facilitate members to access hitherto conditional finance. Housing cooperatives singularly suit such an outfit, where access to seed finance is easier than individuals.

In Kenya, the housing cooperative umbrella organisation, NACHU (National Cooperative Housing Union) is well-suited for accessing seed finance to participate in the proposed housing densification through dweller-initiated transformation discussed here. The spreadsheet model offers sufficient flexibility to permit alternative scenarios for alternative design and technical arrangements.

ACKNOWLEDGEMENTS

The moral, academic and financial support from the University of Nairobi, Southern & Eastern Africa Research Commission on Habitat (SEARCH), Prof. Svendsen of NTNU (Norges Teknisk-naturvitensskapelige Universitet) Norway and Prof. De Troyer of Katholieke Universiteit Leuven (KUL), Belgium is gratefully acknowledged.

REFERENCES

Agevi, E.A. (1992) Building Bylaws and Planning Regulations In: *The Shelter Forum: NGOs and Shelter in Kenya; Seminar Proceedings,* Nairobi, 8

De Troyer, F & Allacker K (2004) Modeling of Financing Mechanisms for Incremental Urban Projects, In: De Troyer F., Verschure H., Allacker K. & Eijkelenburg A. (Eds.) *international workshop: training module rational design and construction-region east Africa* 14 March 2004- 18 March 2004, UCLAS, KU Leuven

De Troyer, F. (1992) *Construction Economics and Cost Control; Application to Developing Countries* PGCHS, KU Leuven

Emig, S. & Ismail, Z. (1980), *Notes on the Urban Planning of Nairobi,* Copenhagen, Royal Academy of Fine Arts, School of Architecture.

Erkelens, P.A. (1991) *Self-help Building Productivity- a Method for Improving House Building by Low- Income Groups Applied to Kenya 1990-2000,* Eindhoven, Eindhoven University Of Technology.

Makachia, P.A. (1995) *Starter Unit Concept- Case-Study Analysis of NHC of Kenya Low Income Housing Projects* Unpublished M.Arch Thesis, PGCHS, KU Leuven.

Makachia, P.A. (2005) A Manual for Organized Self-Help Housing Densification in Eastlands, Nairobi in: *Organised Self-Help Housing Planning and Management-Costa Rica 2005*, HDM, Lund University (CD-ROM).

Nguluma, H. (2003) *Housing Themselves-Transformation, Modernisation And Spatial Qualities In Informal Settlements In Dar Es Salaam, Tanzania,* Department Of Infrastructure, Royal Institute Of Technology, Stockholm

Nordic Council Of Ministers (1998), *Housing Law in the Nordic Countries*, Copenhagen

PGCHS, KU Leuven (1993) Report and Proceedings, Workshop on Housing, Vol. 1 & 2, Nairobi.

Republic of Kenya (1987), *Sectional Properties Act,* Nairobi, Government Printer

Republic of Kenya (1997), *Building Code*, Nairobi, Government Printer

Reutersward, L. (1984) *Transfer and Evaluation of Building or a Building Is Not a Bus*, Lund University, Sweden

Sabana, B. (2005), *The Role Of Microfinance in Economic Development-with Emphasis on Housing Microfinance* in "The Role and Importance of Construction Industry in Economic Growth of a Nation", BORAQS CPD Seminar, Nairobi

Seek, N.H (1983), Adjusting Housing Consumption: Improve or Move, In: *Urban Studies*, (20), 455-469

Sommerfield M. (2001), *Housing Cooperative Programmes In South Africa: Experiences 1997-2001*, NBBL, Norway

Syagga, P.M. & Malombe, J. M., (1994) *Development and Management of Informal Housing in Kenya*, Nairobi, HABRI

Tarekegn, E.A (2000) *KITIYA-Transformation Of Low Income Housing In Addis Ababa,* PhD Thesis, Norwegian University Of Science And Technology

Tipple, G. (1991) *Dweller-initiated Transformations of Low Cost Housing*, Newcastle Upon Tyne, CARDO

Tipple, G. (2000) *Extending Themselves-User-Initiated Transformation of Government-Built Housing in Developing Counties* Liverpool, Liverpool University Press

Tuts, R. (1988) *Optimisation for Use of Resources for Housing Projects* PGCHS, KULeuven

White, T.L.W., Silberman L. &Anderson P.R. (1948) *Nairobi-A Master Plan for A Colonial Capital* London, His Majesty' Stationery Office

Zeisel, J. (1980) *Inquiry by Design: Tools for Environmental Behaviour Research* Brooks / Monterey, Cole Publishing Company