Final report

International Growth Centre

Incremental housing, and other design principles for low-cost housing

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September 2016

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Laura Sara Wainer, Billy Ndengeyingoma, and Sally Murray

September 2016

Abstract: This policy note summarises lessons from a workshop on incremental housing held in Kigali in 2016, and led by Laura Sara Wainer and Bill Ndeneyingoma from the MIT's Resilient Cities Housing Initiative. The workshop was hosted by the Rwanda Housing Authority (RHA) and International Growth Centre (IGC). We review here key design principles for a successful pilot incremental housing project, regarding land management, housing architecture, building materials, and infrastructure, drawing on lessons from international experience and context-specific challenges and opportunities.

For more information on anything contained in this report, please contact rwanda@theigc.org

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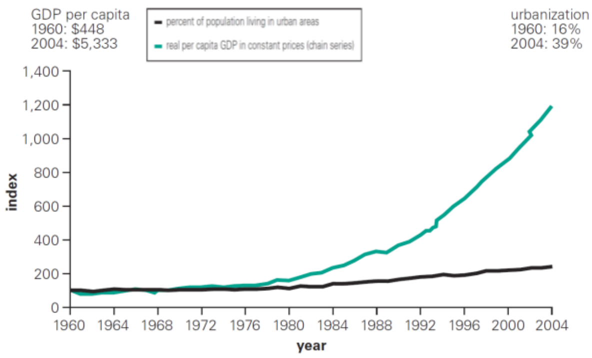
Introduction: Motivation, International Lessons, and Approach

A Low-Income Housing Crisis

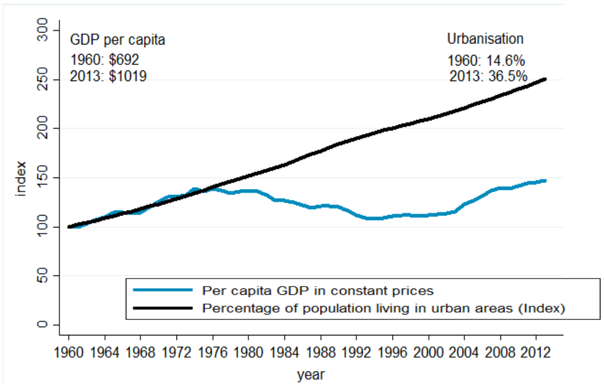
The urbanisation of the Global South between 1950 and 2020 has taken place at an unprecedented speed, more than double the speed of urbanisation in the Global North. Furthermore, while urbanisation has been accompanied by strong economic and employment growth in East Asia, migration to cities in Sub-Saharan Africa has also occurred for reasons other than the lure of plentiful urban job opportunities. This rapid, low-income, urbanisation has led to shortfalls in many ingredients that are key to urban success- infrastructure, education, financial access, and often most visibly, housing (Buckley 2015, Pieterse 2013).

Figure 1. China's Urbanisation and Economic Growth



China's GDP per capita has risen much more rapidly than its urbanisation rate since 1960, providing good resources to finance the infrastructure, education, and housing needed for successful urbanisation

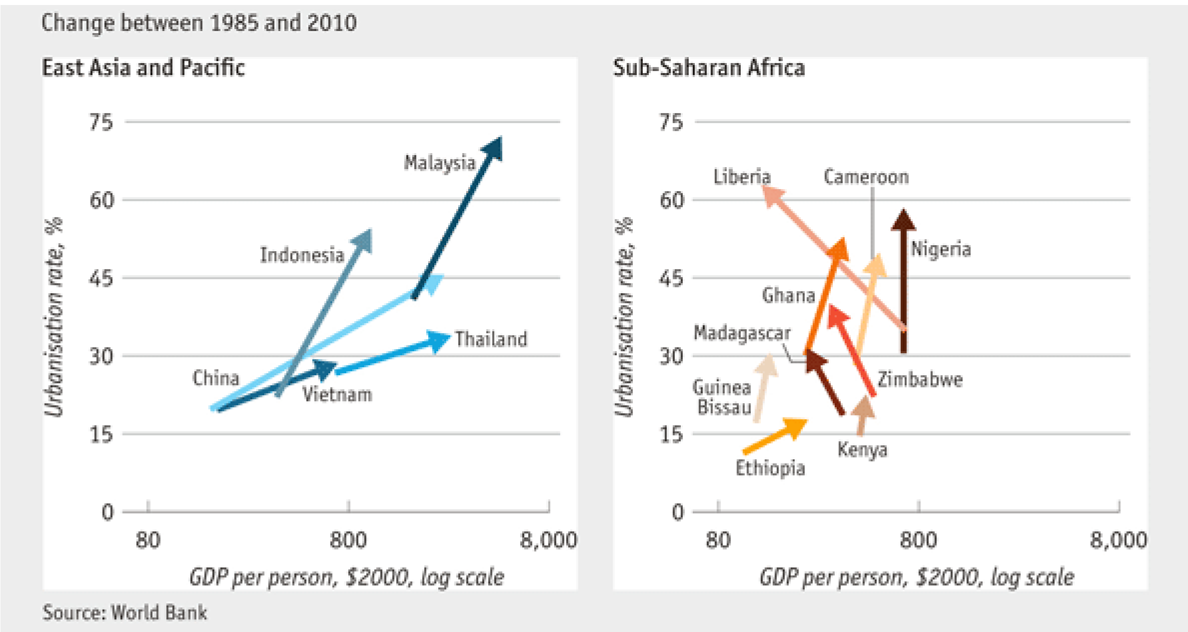
Figure 2. Kenya's Urbanisation and Income Growth



By contrast, Kenya's urbanisation rate has risen much more quickly than its per capita GDP, creating large challenges for financing successful cities. This reflects the situation in many African countries...

Source: Spence, Michael, Clarke-Annez, and Buckey, eds. Urbanization and Growth. World Bank Publications, 2009

Figure 3. Urbanisation and Income Growth in East Asia Versus Sub-Saharan Africa



Source: The Economist

The problem of housing has been twofold: on the one hand, the majority of people moving to urban areas have lacked the necessary assets and income to acquire a 'decent' house. On the other hand, government programmes to provide, or improve access to, adequate housing units have often missed the mark of affordability for the poor majority.

Now, a growing understanding of the dynamics of the development and expansion of informal settlements has led to more responsive, innovative, housing schemes in various developing countries, to solve the 'dilemma' of housing.

Housing Policy Mistakes of the Past (and Present)

A common response to mass housing shortages- from the USA in the mid 19th century, to developing countries like Mexico and Angola in the last decade- has been government-financed, **industrial production of houses on previously undeveloped sites.** However, these projects often suffer three important mistakes.

The first is to sacrifice location for housing quality. To meet the budgets of the poor, there is a trade-off between the structural quality or attractiveness of a house (which raises construction costs) and the quality of the location (which raises land costs). Poor people most often chose to forego housing quality for the sake of a good location; indeed, in central urban slums in India, rents are often extremely high, with even relatively 'well-off' people preferring to live centrally in the slum than in a nicer home far from work and amenities. Governments, by contrast, wish to provide housing that looks attractive and 'tidy', so rather than cutting *home construction* costs, they tend to cut land costs by building in less desirable locations. As a result, demand for the final housing is low. Many large government housing projects in greenfield 'satellite towns' have become ghost towns, or highly undesirable neighbourhoods with low employment levels and many social problems.

The second mistake is a failure to understand how attractive architectural plans translate to real houses and neighbourhoods on the ground. Often poor workmanship, unexpected costs, and unrealistic initial designs, lead to final house designs quite different from those planned. Furthermore, resources for *upkeep* are not provided, and the impact of the selected *house* design on overall *neighbourhood* feel and functionality is poorly thought-through. These challenges are illustrated in Figure 9 and Figure 10, which compare real architectural plans (left column) with the houses as really implemented (middle column), with the full 'neighbourhoods' that result (right column). Thus, industrial housing schemes tend to be badly designed and executed to provide desirable neighbourhoods and homes.

Finally, housing costs rarely match the budgets of the intended recipients. Although government-supported housing is meant serve the poorest 50%, who have no way to afford decent housing without support, more often government-provided homes are too expensive, and affordable only to middle-income families (who may have better housing options elsewhere and do not require state subsidy).

Massive production of housing is required- but do industrially-produced neighbourhoods meet the need? In many cases, the answer has been no. In fact, often industrially-produced houses do not even reduce costs.

Figure 4. Recent Housing Project in Mexico

Figure 5. Millions of Abandoned Houses in Mexico

Figure 6. Pruit Igoe. Low Income Housing Project, USA 1954

Figure 7. Demolition of Pruit Igoe, 1971

Figure 8. Kilamba Housing Project, Angola (2013)

Figure 9. Mexico's Low Income Housing Projects: The Dream Meets Reality

Source: Buckley, Kallergis, and Wainer, "Addressing the Housing Challenge: Avoiding the Ozymandias Syndrome." Environment and Urbanisation (2016), 0956247815627523

Figure 10. Ethiopia's Low Income Housing Projects: The Dream Meets Reality

Source: Buckley, Kallergis, and Wainer, “Addressing the Housing Challenge: Avoiding the Ozymandias Syndrome.” Environment and Urbanisation (2016), 0956247815627523

New Directions in Affordable House Design

There has, historically, been a ‘battle’ between architects and economists, architects pushing for better quality but expensive houses, and economists advocating minimal-cost housing that is often poorly designed to meet human and economic needs for connectivity and a good family ‘home’.

However, over the past few years, true low-cost housing design, especially in emerging economies facing the challenges of rapid urbanisation, has received increasing attention from serious architects. For example, 2016’s Pritzker Laureate (the most renowned architecture prize in the world) was awarded to Alejandro Aravena, a Chilean architect who works on alternative design approaches for low-income families through his own country’s National Housing Program. The 2016 Biennale Architecture International Exhibition was named *Reporting From the Front*, and focused on pioneering low cost and affordable housing solutions all around the globe. This international attention recognizes that innovative design for low income housing is an excellent policy tool to enhance society, the environment, and emerging economies.

Countries such as Brazil, South Africa, Thailand and Japan have recently been implementing what is known as **incremental housing**, **sites and services**, and **low-cost technological innovations.**

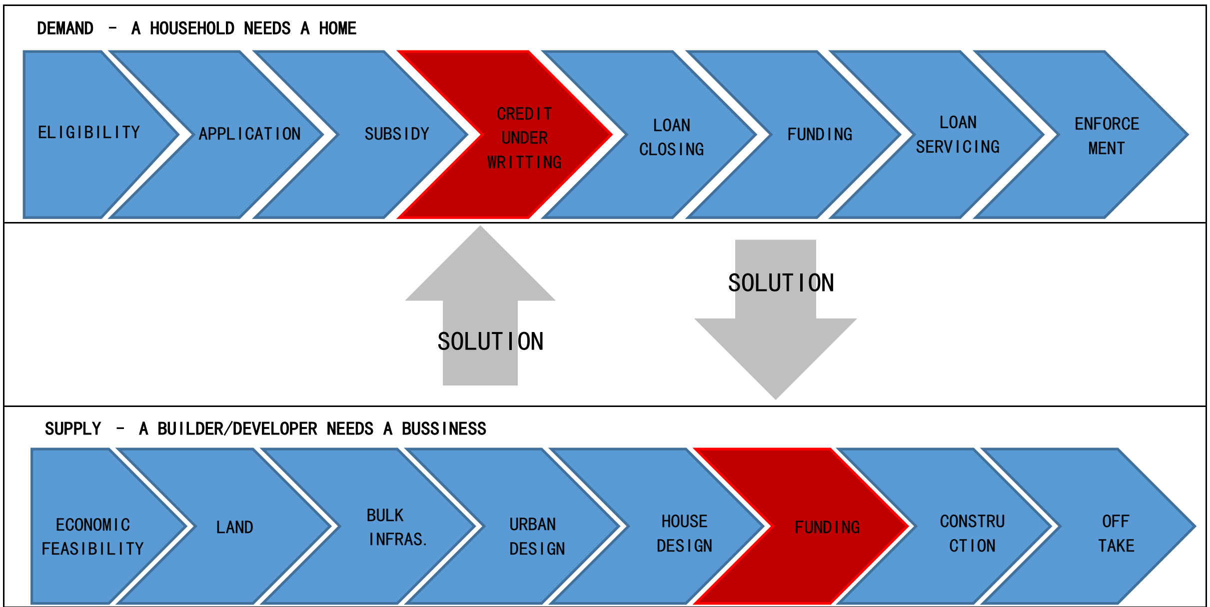
These changes represent an optimistic shift in policy orientation. New approaches to housing typologies and neighborhood design give households the possibility to increase the size of, and otherwise improve, their homes over time. By truly saving on costs, they also enable families to afford a better location. By integrating flexibility into designs, they allow families to adapt the living spaces to their own specific needs. They also enhance subsidy targeting mechanisms, as investments are more likely to go to intended beneficiaries.

At the same time, these innovations and policy shifts face challenges. For instance, innovation must often be aligned to the general standards proposed by older master plans. They must also comply with building regulations, address traditions and aspirations of the residents. And financial access must still be secured for beneficiaries.

The Housing Value Chain Approach

It is important to begin any effort to develop affordable housing by diagnosing the challenge in the particular urban environment. Housing supply costs are comprised of land, house construction, and infrastructure. Demand is mostly constrained by financial access, given a desirable house.

Figure 11. The Housing Demand and Supply Value Chains



These images depict the housing value chain, from a supply and demand perspective. Each blue/red arrow is a value-addition process necessary for achieving effective supply/demand. If even one link in the housing demand, or supply, chain is broken, affordable housing cannot be achieved. If several links are broken, the affordable housing challenge can sometimes seem insurmountable.

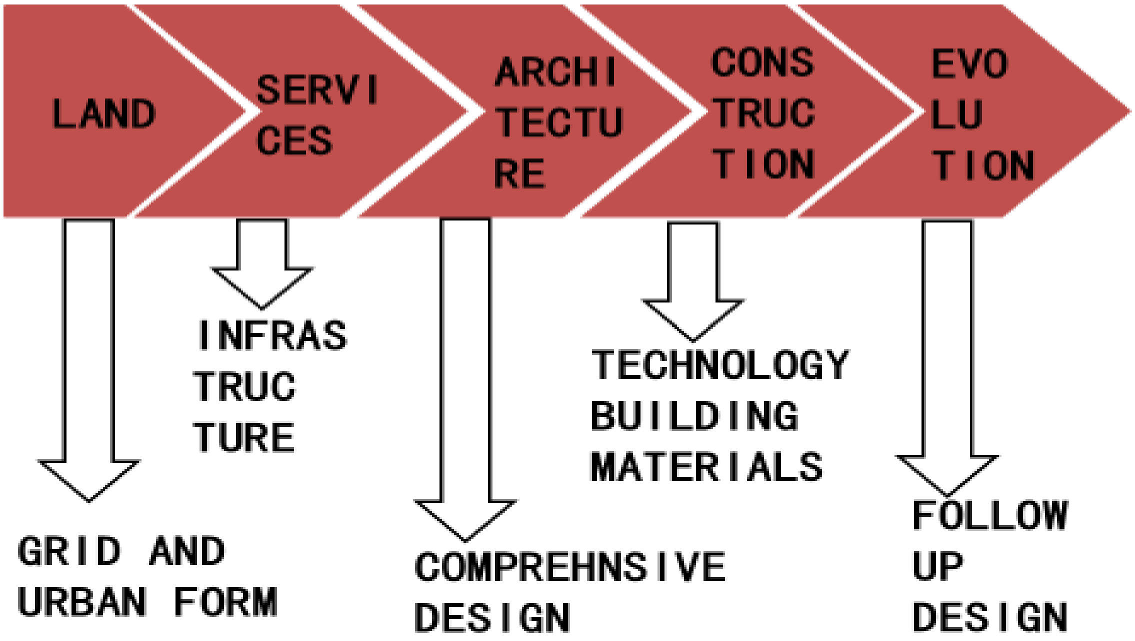
Source: Author's elaboration, Laura Wainer, 2016

The operational framework follows the **housing value chain framework**, which considers that housing production undergoes a series of value-addition processes before reaching the consumer, making the end product more valuable, affordable or exclusive according to parameters selected. There are four key steps in housing supply: **land provision**, **services** access (physical and social), house **construction** (which may be divided into architecture, building materials, and technology), and **evolution** (the maintenance, expansion and renovation of the house over time).

It is crucial to analyse each link in the housing value chain, and identify solutions for weak or missing links. In Kigali, where are the breaks in this chain? Are solutions for each being designed for the planned pilot project?

Design is often seen as relevant only to a few links in the housing supply chain: neighbourhood design and house design. However, each stage in fact has an important design element which can be powerful in reducing costs and increasing the relevancy of the project for the target beneficiary. It is important to establish the role of design at each link, to enhance the relationship between finance and design.

Figure 12. Design-Based Housing Value Chain (Supply)



Source: Author's elaboration, Laura Wainer, 2016

Rwanda's efforts to address housing affordability can benefit from assessment of the housing value chain, and considering lessons from innovative programs in other countries. Sections 2-4 below discuss the key lessons from international experience on design principles for land use, housing architecture, and infrastructure, to deliver effective low-income housing.

Design Principles: Land

Design principles for land use emphasise achieving density without compromising liveability, or creating the all-too-common ‘false densities’ in ‘ghost neighbourhoods’. This is achieved through an effective grid and structures for the management of neighbourhood evolution, which promote without forcing neighbourhood density, encourage a managed increase in density over time, and protect public and private open spaces.

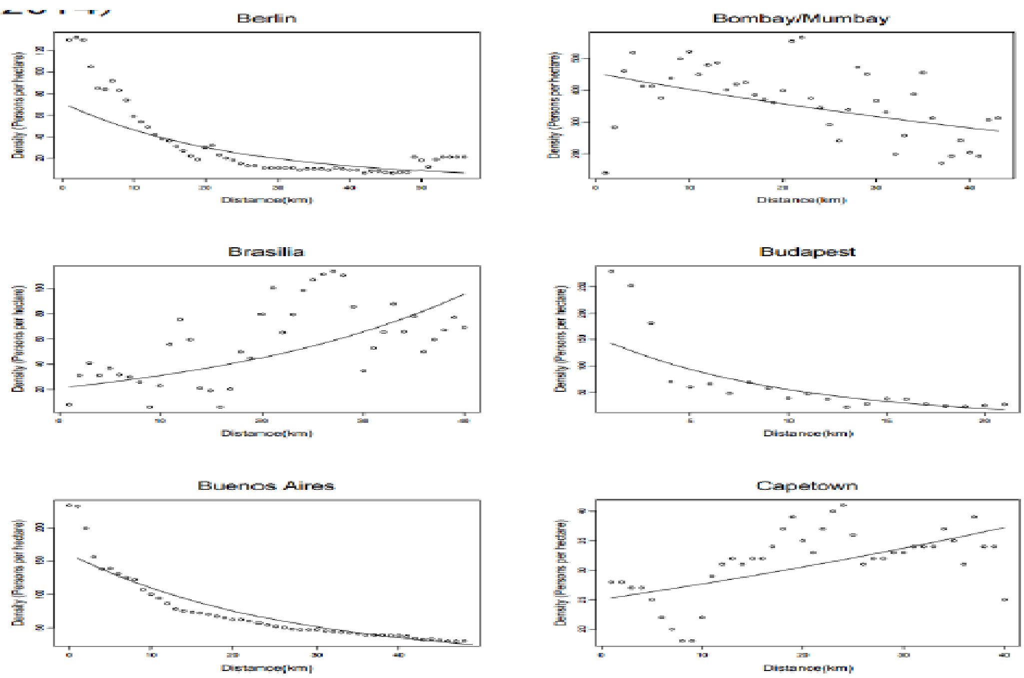
Target Density

A more efficient use of land reduces land costs. The efficiency and density of land use can be measured in different ways: housing floor area to land ratio, dwelling units per hectare, or population per hectare.

Figure 13. Dense European Neighbourhood Design

In most cities around the world, density is highest in the centre, and lowers progressively further out of the city. In certain cities (e.g. Brasilia, Cape Town), however, this is reversed. Studies have shown that this reversed-density pattern makes almost all trips longer and more expensive, and commuting costs become particularly high (Bertaud 2005). In Cape Town, 86% of residents cannot access a marketplace through affordable transport means, and 47% depend on full housing subsidies and social transfers. Connectivity is the catalyst that makes urban-led economic growth so effective, and such frictions corrode the connectivity of the city, limiting its economic potential significantly.

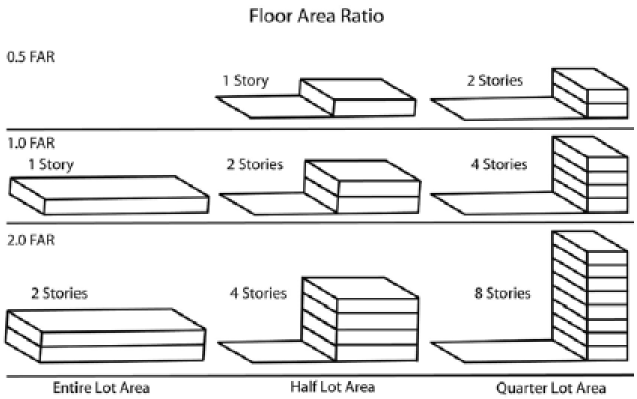
Figure 14. Density by Distance to the City Centre in Six Cities



Source: Bertaud, Alain and Malpezzi, Stephen (2003)

A common approach when targeting density is to build very tall apartment blocks. However, these suffer problems of high maintenance costs, high initial construction costs, need for centralised management that is often lacking or poor quality, and a lack of identity and responsiveness to residents' needs. On the other hand, large-scale, *low* density housing estates are also often unsuccessful: infrastructure costs become extremely high, environmental footprints are large, maintenance is expensive, and people often abandon the houses to return to better-located slums.

Figure 15. Different Designs to Achieve the Same Floor Area Ratio



Density can be achieved through higher buildings, but also through more 'human-scaled' units and optimisation/minimisation of 'unused' land. The theory behind this is illustrated in Figure 15, which shows how the same floor-area ratio can be achieved through either increasing the number of stories, or reducing 'undeveloped' land on a plot/neighbourhood. It was found, for example, that European-style neighbourhoods with 2-3 storey terraced houses achieves one of the highest density neighbourhoods of any design (Figure 13), while all the neighbourhoods in Figure 16 have similar total population density, achieved through very different designs.

Figure 16. Different Designs for Density

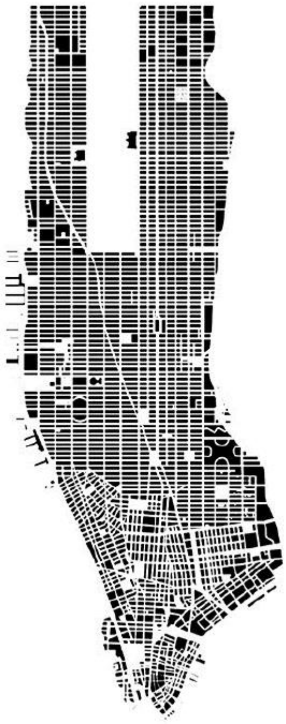
To achieve density in the right way, it's important to study the target beneficiaries of a project, and understand what trade-offs they are and are not willing to make for the sake of location. If the location is not right, international experience suggests that people will tend to shun the housing and return to, or remain in, the more central slum.

Typically, density can only be facilitated, not created, through neighbourhood designs, regulations, and financial access that make it easier for **density to increase with time, and in a better-managed way, as the land value and location desirability increases**.

Urban Form: The Grid

The urban grid was the first urban design and planning innovation in history. Grids were applied in several countries, but most famously in Manhattan, the 1811 Master Plan for which greatly facilitated the growth of the city, reducing institutional frictions and increasing the value of properties.

Figure 17. The Manhattan Grid



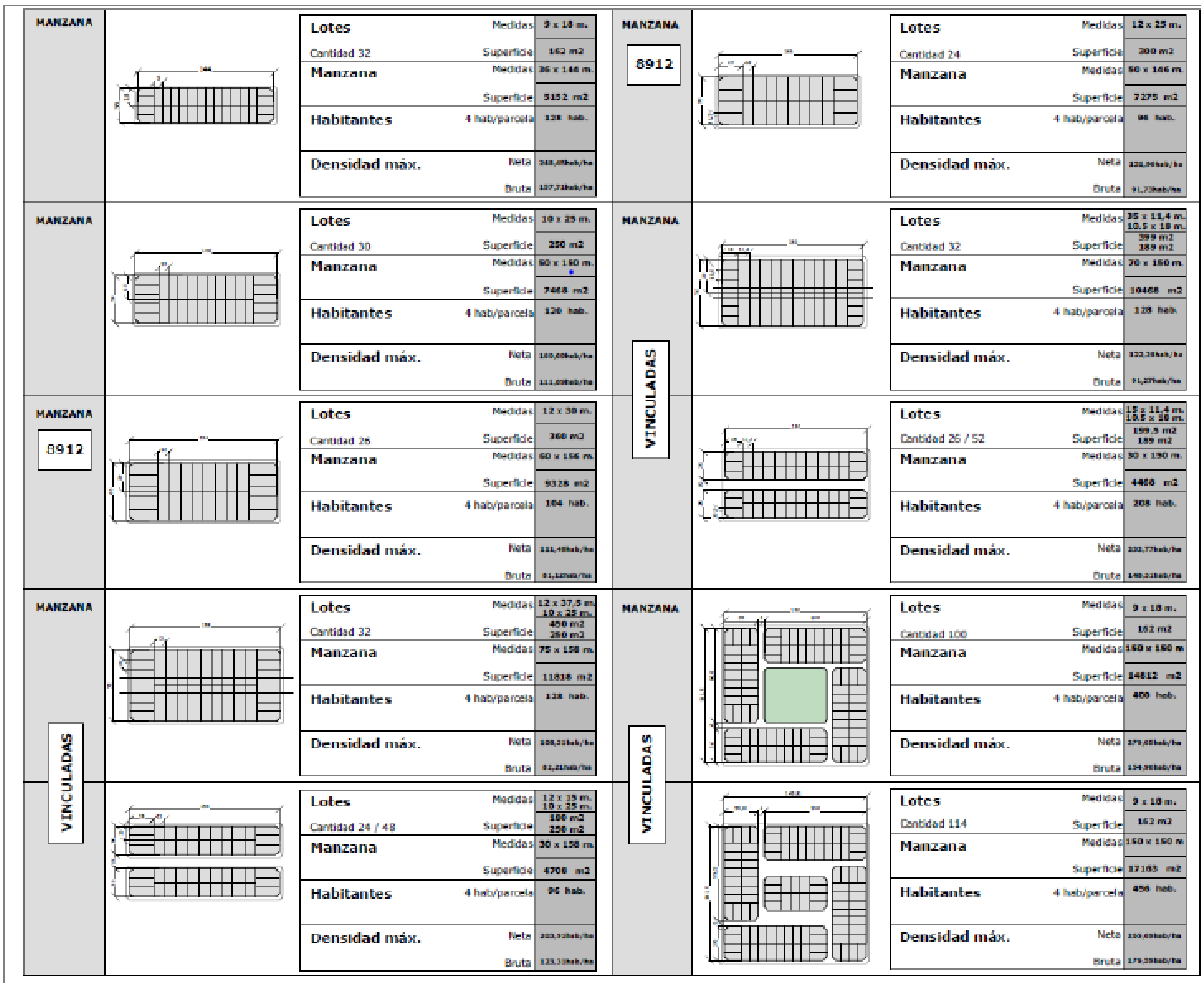
What are the components component help a grid deliver density and liveability?

Plot sizes matter considerably to achieve profit-maximising residential density. Regardless of building height, **costs are lower the smaller the plot size**.

Public spaces and infrastructure- changing the balance of wide versus narrow roads versus footpaths, changing route design and access points, remodelling public spaces, and so on- also impacts density. Block and grid designs should be modelled and analysed carefully for density and liveability, to achieve an optimal grid for the local context. An example of this kind of modelling is shown in Figure 18 below.

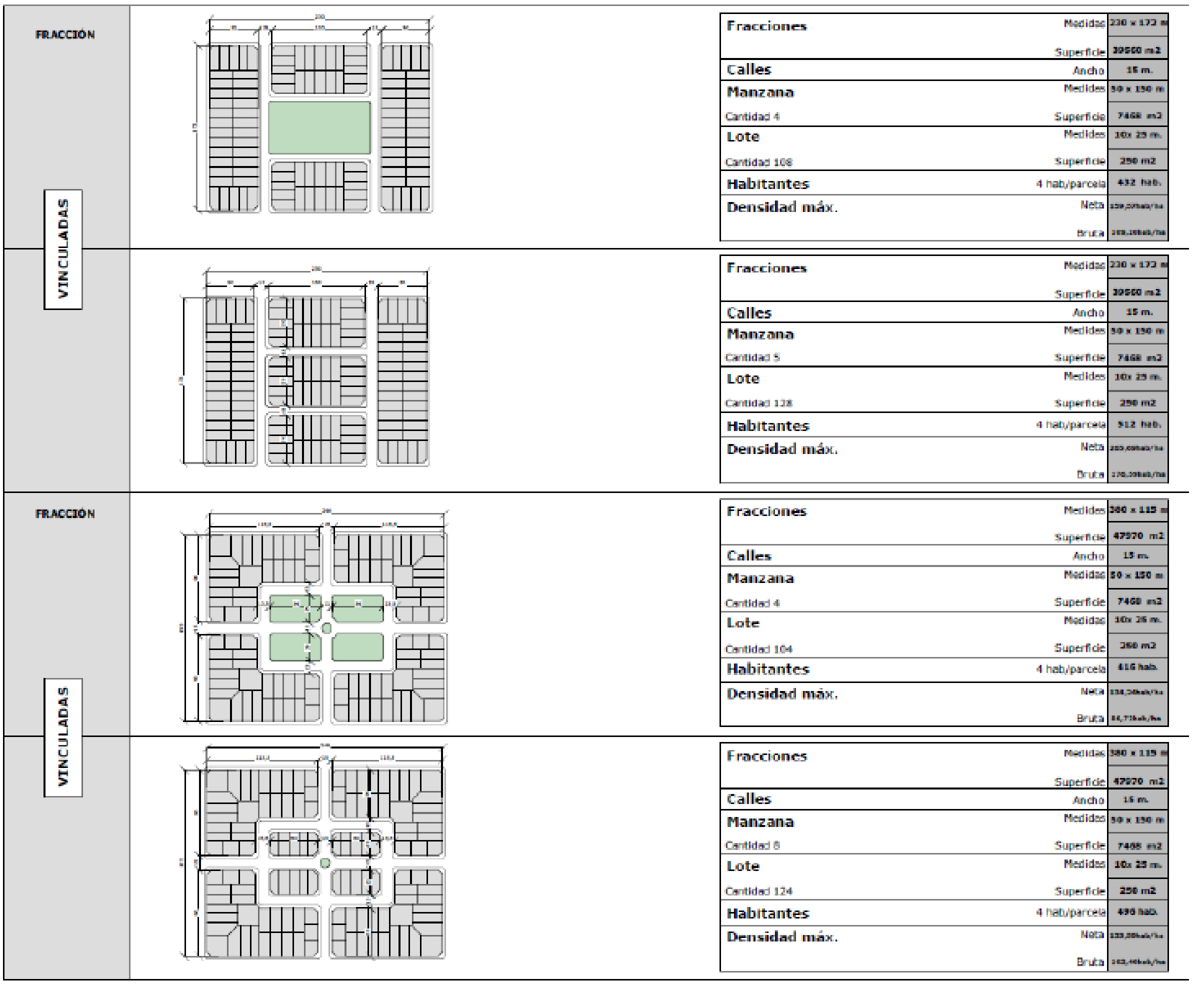
A grid should also embrace some flexibility, to facilitate the gradual increases in density and changes in neighbourhood character over time. Planning regulations should be dynamic and adaptable, especially in emerging cities where the needs and means of low-income households, and the shape of the city, are evolving rapidly. Grids should support households to incrementally develop their neighbourhoods and houses, albeit ensuring decent community spaces and infrastructure are protected. For example, street paving and parking needs can be planned to be upgraded and expanded over time as the needs of the neighbourhoods change, planning in advance where the principal streets will be. In addition, spaces that are initially public can be planned for new housing if and when demand arises, so that higher demand can be incorporated in a way that complements rather than compromising neighbourhood character. The bottom left panel of Figure 16 portrays a neighbourhood where this densification was not planned or managed, leading to backyards crammed with informal huts.

Figure 18. Modelling Block Designs for Density Assessments



Source: Laura Wainer (2010), Almirante Brown Urban Plan, Buenos Aires, Argentina

Figure 19. Modelling Block Designs for Density Assessments, Cont.



Source: Laura Wainer (2010), Almirante Brown Urban Plan, Buenos Aires, Argentina

Design Principles: Infrastructure

Complementary to the grid, is of course the infrastructure provided to service plots. The Government of Rwanda has a policy to subsidise infrastructure for low-cost housing, through the Urban Infrastructure Fund. How can infrastructure be designed to achieve affordability and liveability for the neighbourhoods?

Sites-and-Services Approach

The concept of sites-and-services (S/S) has been implemented, through the World Bank assistance, for about two decades in many developing countries, mostly in the 1970s and 1980s. It targets the housing needs of the bottom end population, and emerged in the face of the failure of conventional housing approaches and in the context of structural adjustment pressures to reduce government spending. Thus, the sites and services approach advocated the role of government agencies only in the **preparation of land parcels with certain basic infrastructure.**

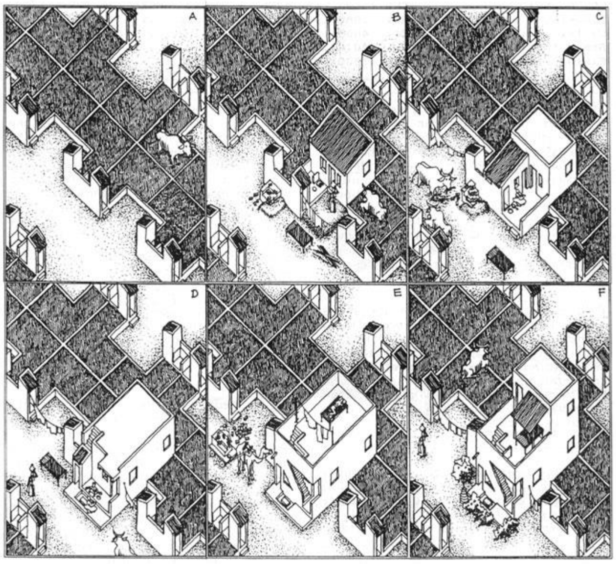
The level of infrastructure provided was determined by the payment capacity and willingness of the beneficiaries: projects sponsored "packages" of shelter related services which ranged from the minimal level of a 'surveyed formal plot', to an intermediate level of 'serviced sites', to an upper level of 'core' (plot, infrastructure, and foundations). In addition, a sites and services project might provide:

- A utility wall: built on the plot, containing connections for water, drainage, sewerage, and electricity. The beneficiaries build the house around this wall, and utilize the connections from it.
- Sanitary core consisting of a bathroom/toilet, and/or a kitchen.
- Latrine: Due to its critical waste disposal problem, many project provide a basic latrine
- Roof frame/ core shell house: The roof is the costliest component of a house and requires skilled labour to build. Therefore, some projects provide the roof structure on posts, and the beneficiaries have to build the walls according to their requirements.

Most steps of house-building were left to the beneficiaries themselves, to use their own resources, formally or informally.

Three important considerations are central to the concept of S/S according to the WB: (1) the projects must provide a package of benefits that is widely **acceptable and affordable to the beneficiaries** (the charges must be small mortgage repayments, generally not exceeding 20% of income); (2) the cost of the project must, to a great extent, be **recoverable**; and (3) the programme must be capable of being **replicated** by others for urban housing and community services.

Figure 20. Sites and Services Illustration, Ahmedabad, India, 1984



There are several perceived advantages of sites-and-services approach. It rapidly gives legitimate ownership rights to recipients, helping families mobilize savings for shelter. Under an incremental build approach, it organizes, partially formalizes, and speeds up the incremental build process. It helps government prioritize reserving adequate land for low-income housing as part of a more rationalized city growth plan when resources are scarce. It mobilises and improves coordination among infrastructure, utilities, and service providers. And it lowers the cost of housing production for government and for homeowners. It's a flexible approach that can be used for neighborhoods of quite different styles, as the SS examples below from India, Namibia, and The Philippines, illustrate.

However, sites and services is not a solution to all low income housing problems, and faces several constraints.

The biggest implementation problem was that governments were not willing to allocate public lands in appropriate locations. Housing the poor was not the priority for most governments at the time, as it is becoming today. Furthermore, location was not treated as a core of housing policies in the 1970s and 1980s. So, with high land costs in urban areas, most sites and services schemes were located on the fringe to save money. This, however, caused two problems: first, infrastructure costs rose (and often delayed projects) due to the large distance between the site and existing networks. Second, residents' travel to employment centres would be lengthy and expensive, discouraging many beneficiaries to take advantage of the schemes.

Another challenge came from bureaucratic procedures. Selection procedures, designed to ascertain that applicants meet eligibility criteria, tended to be complicated, time-consuming, full of bureaucratic pitfalls, and provided ample opportunities for corruption.

Loan eligibility was another challenge: for many low income families, the eligibility criteria were impossible to meet due to informal sector jobs or low, irregular incomes.

A lack of coordination and unclear spread of responsibility between the various implementation agencies led to considerable delay in the final provision of infrastructure and services, even after the land had been allocated to the beneficiaries.

Standards were a further challenge. High standards on land use, construction, and building quality made schemes unaffordable to the target beneficiaries. Some schemes, for example, prohibit income-generating activities on residential plots, including rental of rooms: they, thereby, limit the opportunities for residents to earn an (additional) income to pay for their plot and their house.

Figure 21. Ahmedabad, India, 1984

Figure 22. Namibia

Figure 23. The Philippines

Most sites and services schemes were thus plagued by poor cost recovery. This is due to failure to change conventional attitudes and preferences in the government and among prospective homeowners about what is acceptable, appropriate housing. Completing the incremental process takes time, and a project **may not look "tidy" or "attractive" for years**; politically, this can be a problem.

However, the most prevalent challenge for cost recovery was that households could not afford to build a house to move into. Often there is the **expectation that they would not move into the plot until the house was 'finished'** and polished. Financing a house, after already financing the plot, is a problem for many households. Thus, the **financing component** of the housing demand value chain is now understood to be critical to the success of any incremental or sites and services project.

Despite these challenges, recent contemporary studies suggest that SS projects were **more successful than they appeared in early years**. Many of the sites were being used well twenty years later, even though five years after completion results were disappointing. A study of Aranya sites and services project in India found that houses were indeed built gradually but successfully, as homeowners continued to undertake incremental housing construction that matched their own needs and ability to generate resources. In initial stages of development, people used inexpensive materials, but in later stages, people mainly use bricks and reinforced concrete as construction materials, resulting in more solid and permanent structures.

The study of Aranya looked at the functionality of different elements of the project: plot layout and dwelling units, cluster level open spaces, neighbourhood level open spaces, street layouts, community level open spaces and landscaping. Small open spaces were found to played a vital role, especially in a low-income neighbourhoods. Such places were used differently according to residents' needs, for example, as: a small temple, festival gathering place, resting platforms, tree plantation, clothes-drying place, and storage place. For large open spaces, people have used them as temples, gardens, and large gathering sites. But unfortunately, a lot of large open spaces have been left empty, and some are even full of waste.

Certain generalisable lessons therefore emerge from studies of sites and services projects around the world.

1. *Sites-and-Services plots need special planning and engineering standards, and an appropriate package of basic services*, not only to lower costs ,but also to make subdivisions more livable while supporting incremental building processes.

2. *A plot alone does not solve the shelter problems of low-income households*: *Sites-and-Services* programs should provide a package of basic needs at the time of allocation: land, infrastructure, community services plus access to financing.

3. *Households might not afford a plot and to build a complete house*. Sites-and-Services programs should include mechanisms (combining savings, subsidies and credit) to help households finance and incrementally build a house.

4. *The location of the subdivision is important:* Low-income Sites-and-Services location is critical for access to low cost public transport, access to schools, and jobs, and thus the success of the project.

5. *Subdivisions should emphasize efficiency and incremental development standards of both the neighborhood and the residential plots:* By adjusting design parameters (i.e., using engineering norms appropriate to incremental development) and efficient land use layouts (i.e., the ratio of residential land compared to public uses such as streets, etc.), subdivisions can increase residential density, lowering the unit cost of developing the site (more plots can be produced on the same amount of land and more land can be used for community facilities). Layouts of streets and plots should minimize the amount of infrastructure needed (i.e., by lowering the *ratio of network length per plot)*. This substantially reduces the cost of the entire subdivision and the individual cost per plot.

Infrastructure for Resilience

Contemporary infrastructure literature stresses the role of infrastructure in securing the resilience of a neighbourhood. How can infrastructure and site-layout be used to reduce risks of flooding, erosion, fire damage, and communicable disease? Furthermore, how can infrastructure improve the economic resilience of a neighbourhood, reducing recurrent spending on utilities and repairs, and even creating income-generation opportunities?

Resilience is a paradigm that will likely define urban public housing policy and implementation over the next decade, as public works, supportive housing strategies, and the involvement of private sector served as frameworks for urban public housing strategies between 1950 and 2000 ("Urban Public Housing Strategies in Developing Countries", Patrick Wakely). Rwanda's policies related to green growth, climate resilience, and the built environment have already laid the path for resilience to act as a driving force behind affordable housing. For instance, the "Green Growth and Climate Resilience

National Strategy on Climate Change and Low Carbon Development" delineates the responsibilities of cities and their built form with regard to the environment.

Moreover, existing studies and projects in Rwanda and elsewhere continue to expand on the concept and the practicalities of infrastructure for resilience. One example study is "Building Neighbourhoods that Build Social and Economic Prosperity: Manual for a Complete Neighbourhood". This outlines that a complete neighbourhood would require infrastructure to support services ranging from storm water management to food production. The manual diagrams pathway and plot layouts to prevent erosion, and suggests a waste to energy closed system loop to ensure energy self-sufficiency. Waste recycling would be performed thanks to on-site biogas facilities, an approach that could be linked with Rwanda's National Domestic Biogas Program.

Another conceptual and practical approach to infrastructure for resilience is low impact development. The University of Arkansas' "Low Impact Development: A Design Manual for Urban Areas" defines low impact development as an ecologically-based storm water management system. The system proposes ecologically-based technologies – a so-called soft engineering approach- to treat, store and evaporate water runoff instead of relying on traditional pipe to pond infrastructure channels. The Low Impact Development manual is a recipient of the 2011 American Society of Landscape Architecture Excellence Award, an award that the Kigali City Master Plan won in 2010.

Figure 24. Light Earth Designs, Manual for a Complete Neighbourhood: Erosion Resilience

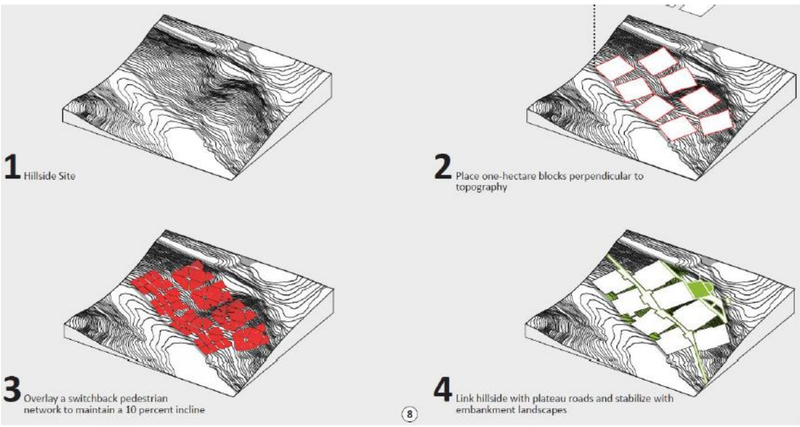


Figure 25 Light Earth Designs, Manual for a Complete Neighbourhood: Flooding Resilience

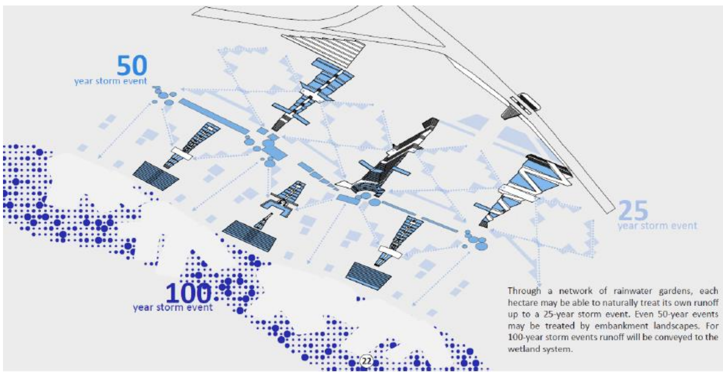


Figure 26. Light Earth Designs, Manual for a Complete Neighbourhood: General Illustration

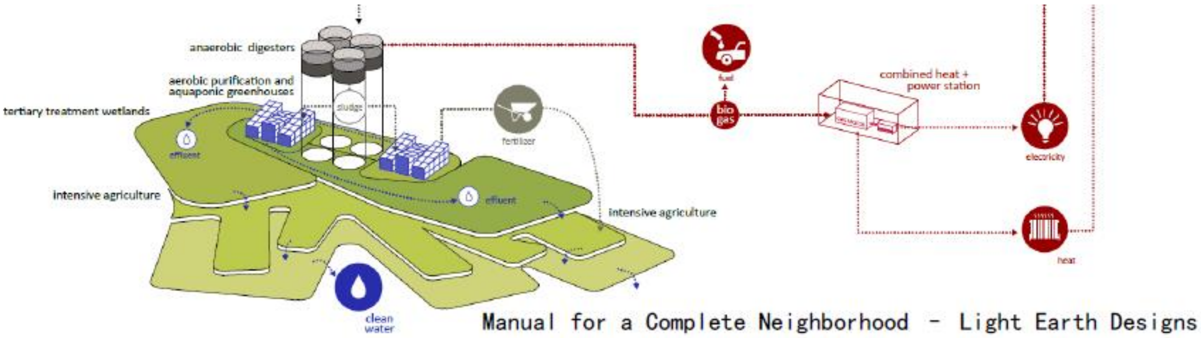


Figure 27. Biogas Options for Reduced Energy Costs

System	Total cost (USD)	Firewood cost per day* (USD)	Number of months needed to break even&
EWSA concrete tank	984	0.55	60
EWSA concrete tank, with subsidies	176	0.55	11
New EWSA plastic tank	735	0.55	45
New EWSA plastic tank, with subsidies	74	0.55	5

Design Principles: House Architecture

Thoughtful and comprehensive design of the house itself plays a fundamental role in addressing housing costs. It also speaks to other pressing resilience challenges: mitigating the impact of natural disasters, reducing energy consumption, providing economic opportunities to the less privileged, and creating welcoming public spaces. This section focuses on international learning regarding housing design innovation for low-income housing.

The key methodology explained herein is "incremental building". Incremental building is not the same as building small, complete, houses that can be extended later. Incremental building, rather, provides "**half of a better house**": the houses are delivered **incomplete**, though typically liveable, for the owner to improve and 'complete' gradually over time.

The main aim of this approach is to **reduce up-front capital costs** of the house, so that the house can be built affordably in a truly **desirable location**. However, it also allows the owner to **design important details of their house according to their own needs**, and to improve not only occupancy capacity but also the 'polish' and interior design of their homes **as their incomes and demands increase**.

Incremental Build Case Studies

An exemplary incremental build project is architecture firm Elemental's project in Santiago de Chile. Elemental worked within the Chilean National Housing Program, which provided fully subsided units to those at the bottom of the income spectrum who laked borrowing capacity. The program provided a capital subsidy of US$7,500 (now up to $10,000) per family to finance the purchase of land, infrastructure and architecture.

Elemental found that the capital provided by the National Housing Program would cover *half* of the production cost of a low-cost house in the private market. They saw that mass-production was unlikely to reduce the cost of single unit by more than 15%. They found that the most expensive component of the housing in Santiago de Chile was land.

The cost of land, however, varies significantly from one location to the other. In general, Latin American governments choose to deliver a fully finished house in a poorly-located area, while the preferences of the people indicate the opposite. However, Elemental next **conducted market research on the demand of the target group**. This showed that low income communities were likely to trade in housing quality for a good location with access to jobs. Celhay and Sanhueza (2011) show that other Chilean public housing projects created social isolation and limited access to real economic opportunities. **In their analysis, low-income families that stayed in the slums were shown to have better socioeconomic outcomes, higher rates of labor participation, and better employment rates than formal housing beneficiaries**. Lall et al. (2012) reach similar conclusions about South Africa, where people often choose to live in a better-located shack than in a subsidized, higher-quality, unit that provides less access to job opportunities. They also found that public housing provision results in poorer maintenance and upgrading of the facilities provided.

Elemental saw that producing a quality location is far more difficult than simply improving a house. Improving a house can be done at the individual scale, while improving a neighbourhood and location involves communities, businesses, and governments. However, constructing the house could be relatively simple: in Latin America, there is a long tradition of self-construction, and many low-income residents in fact work in the construction industry and related sectors.

So Elemental decided to construct ***half of a house*** in a ***well-located area***. This forces the beneficiaries to, over time, dynamically transform the simple housing solution offered in a complete and personalized home, according to their own investments capacity and preferences.

The ‘half-houses’ provided were two-storied, with space left between houses for expansion. The second story was provided in line with a fundamental principle of incremental building: the **most expensive and fundamental elements of the house should be provided**, and cheaper elements left to residents to create. Similarly, the interior was left extremely bare and ‘unfinished’-looking, for residents to decorate, add partition walls or screens, etc, as they wished. Staircases and a ‘wet core’ (plumbed space) are more expensive, so were also provided, but again, in a very basic form.

Figure 28. Incremental House, Santiago de Chile, by Elemental (Left: Initial House Delivered. Right: Personalised Houses After Time)

Figure 29. House Interior, When Delivered (Top) and Another Interior After Time (Bottom)

Figure 30. Interior Staircase as Delivered to Recipient

Figure 31. An Interior Staircase After Personalisation

Another incremental build project of interest comes from eSTDUIO in Mexico (**Error! Not a valid bookmark self-reference.**). eSTUDIO provided a simple ground-floor house, and on top a flat roof with stairs leading up to an empty block, or in some models, an upstairs 'wet core' (plumbed bathroom space). This block was named the "possibilities block", and was designed to encourage addition of a full second story with time.

The 'wet core' was located in order to be back-to-back with the *adjoining* home's wet core, to reduce plumbing costs. This again illustrates the key principle of incremental building, to provide the most expensive and essential elements of the house, and **do so in intelligent ways that save costs**. Thus, the basic plumbing, foundations, stairs, and load-bearing walls are more costly than mere partition walls, so are provided. This approach makes it easier for the inhabitant to adapt the house over time, even with limited financial access.

eSTUDIO included several different variations on their basic house model in the same block and neighbourhood, to present options to recipients and improve the neighbourhood diversity and feel.

Figure 32. eSTUDIO vS "Possibilities Block" Design (Mexico)

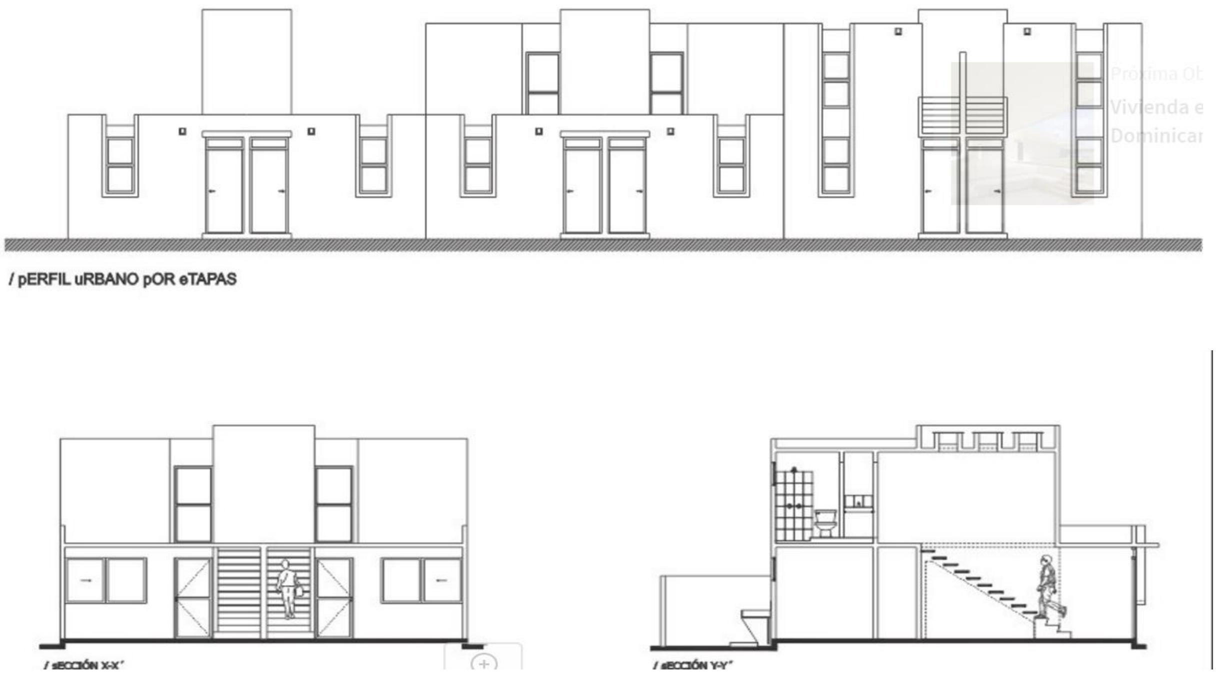


Figure 33. eSTUDIO "Possibilities Block" Constructed

Another incremental build project (shown in Figure 34) was designed and constructed by the resident, himself a construction worker. The image below shows the outdoor living space with simple covered roof, which the resident intends to close over time. This example also highlights that **climatic conditions** must be considered in choosing appropriate incremental models for the environment. In line with incremental principles, the owner also left the inside rather bare upon first completing the home (Figure 35. Owner-Built Incremental House: Interior), to add embellishment over time with income. The construction and initial finishing costs of the house was $5,900. This project is helpful for demonstrating firstly, that projects benefit when residents are well informed about building practices, and secondly, that even quite **simple** incremental components can be effective and helpful to residents.

Figure 34. Owner-Built Incremental House

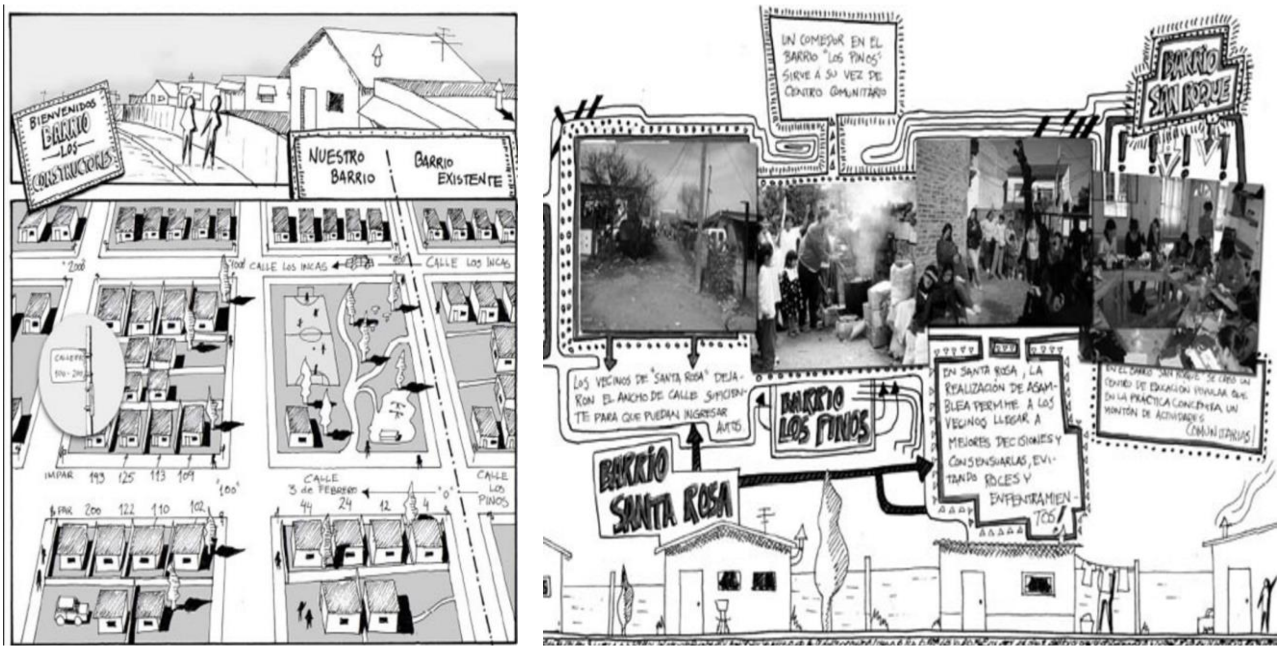
Figure 35. Owner-Built Incremental House: Interior

Managing Evolution

A housing project's success relies not just on the initial house and grid provided, but on the **evolution of the houses and neighborhoods in the mid and long term**. Maintenance, and quality building renovations, represent a significant challenge for low income households. In addition, people will continue to build extensions on their own, which either bring positive, livable, density to the neighborhood, or encroaches on important public spaces and brings down neighbourhood quality.

Increasing residents' construction know-how is critical. In much of Latin America, comic books are very popular, and so the government used this readily-available mechanism to produce handbooks teaching principles of home maintenance, use, and renovation. The visuals and attractive style keep the handbooks accessible even to those with lower levels of literacy. Such tools could be helpful in the Rwandan context, where there is less of a tradition of self-construction of houses with a reasonable quality standard, and where literacy and reading culture are still developing. However, means to improve construction know-how should be developed considering the local culture and existing strong mechanisms. Villages and sectors, through local officers, community meetings, and community works like *umuganda*, for example already provide an opportunity for developing construction skills.

Figure 36. Handbook on Use, Maintenance, and Renovation of Homes (Argentina)



Successful housing projects **plan in advance where houses may be extended over time**. The project pictured below, from Brasil, included provision for even apartments to be expanded, with connecting corridors, balconies, and renovation of the roof as a living space. Blocks could also be added at the end and sides of the buildings (Figure 38). In line with best practice, the design aims to present a **range of possibilities for expansion**. This was incorporated considering residents' needs for a flexible use of space, which is characteristic of the favelas.

Figure 37. Managed Expansion (Brasil)

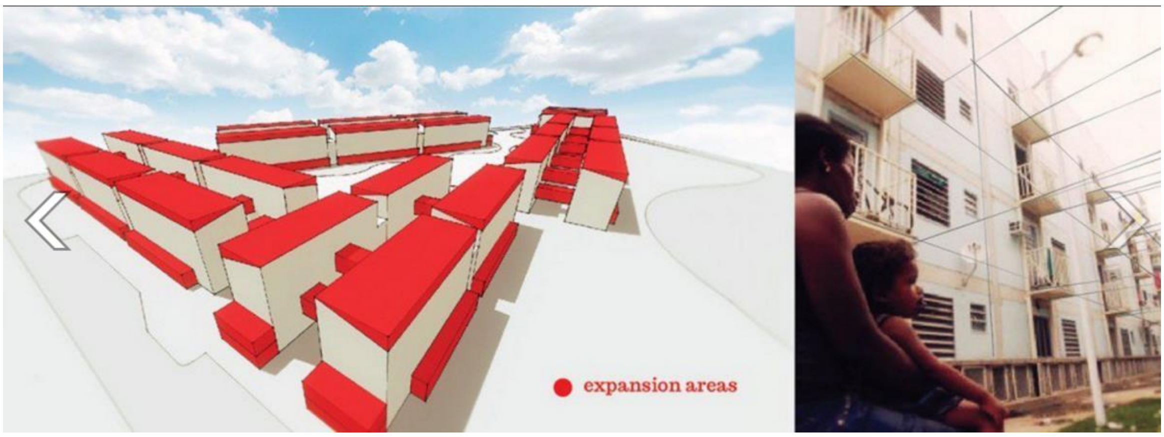


Figure 38. Managed Expansion (2) (Brasil)

Of course, as well as planning, monitoring and enforcement in follow-up stages are key; however, they are often ignored. Figure 39 below shows a project where expansion was neither planned, nor illegal expansion monitored and penalized. Between the long silver rows of houses, architects had planned gardens as open space. However, ownership of this open space was never made clear, and usage was never monitored. Due to the high desirability of the location, people began to put small shops, and then small bedroom shacks, in these 'yards', leading to a poorly-planned crowded neighbourhood with no public spaces, poor access, and insufficient infrastructure and services. Rwanda has generally been very effective at enforcing proper use of protected or public spaces, and this is promising for any low-income pilot project and should be upheld.

Figure 39. Squatter Settlements in 'Gardens' of a Public Housing Project

Key Conclusions for House Architecture

- Give the people what they cannot produce themselves (well-serviced land, infrastructure and foundational structures are more important than the house);
- Tailor projects and support according to existing building systems and knowledge;
- **Ask** people about their preferences. Many incorrect assumptions are made innocently by policy makers and designers;
- Location has better multipliers effects on wealth than housing quality;

- You need good designers and strong community engagement, to connect demand and supply of design (such as Public Architecture NGOs);
- Planning and follow-up to manage the evolution of the house is at least as important as the delivery of the project itself.

Design Principles: Building Materials

The 2012 EU Housing Study of the City of Kigali estimated that by 2022, to meeting housing demand, over 200,000 tons of cement, 15,000 tons of clay, and 20,000 tons of steel would be required. This section briefly showcases building material innovation in Rwanda and the region which is bringing down the pressures on building material supply and costs.

Earth Bag Construction

Brick prices have increased dramatically in Rwanda in recent years, especially with restrictions on traditional burning and tree-felling. General Architecture Collaborative and Rwanda Village Enterprises have experimented with replacing bricks with earth bags to reduce wall costs.

Figure 40. Earth Bag Construction in Masoro

Figure 41. Finished Earth Bag House, Masoro

In South African, MMA Architects have even created two-story houses using earth bags inside wooden and steel frames. Thus, the material can be robust, and is often much cheaper than fired brick.

Figure 42. Two-Storied Earth Bag House Under Construction, South Africa

Compressed Earth Blocks

Compressed earth can create reasonably strong, stable, houses at a fraction of the cost of traditional bricks. The main equipment needed is the compressor, which can be powered manually, and shared across several construction projects or communities. Designs can also intersperse compressed earth blocks with more traditional fired bricks, as seen in the example from Rwanda Village Enterprises below (Figure 44).

Figure 43. Compressed Earth Block House and Construction

Figure 44. Mixed Compressed Earth and Fired Brick House, Rwanda Village Enterprises

Other locally-available building materials include eucalyptus, StrawTech (both of which are strongly renewable), and bricks fired using waste coffee husks.

Figure 45. More Locally-Available Building Materials

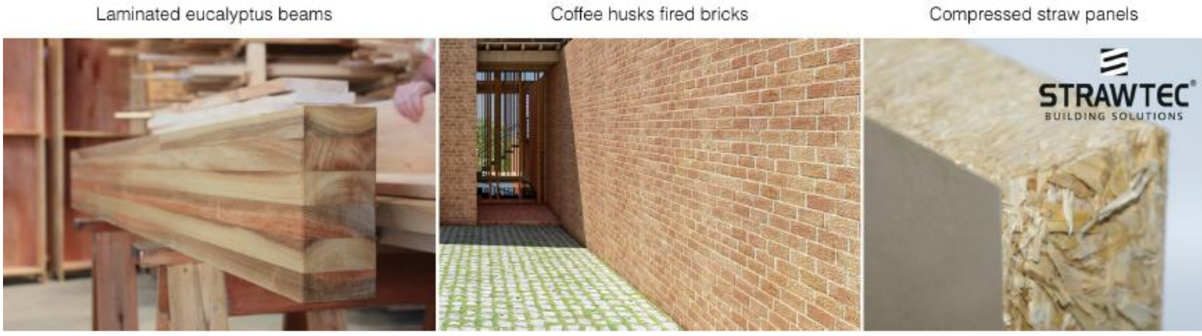


Figure 46. Strawtech Model House

Improved Fired Bricks

Even fired bricks can be optimised, to reduce costs and/or improve stability- which is important, because they are likely to remain the material of choice for most people. SKAT have done extensive research into improving the sustainability of the brick industry, and improving the range of bricks produced in Rwanda.

Figure 47. Bricks in the SKAT Office, Kigali	*Figure 48. SKAT Model House*
	

Conclusions

This report has explained the importance of an effective interaction between finance and design in the housing value chain, showing how each can benefit from the other.

Implementing a pilot project will always be riskier and more prone to 'fail', than implementing tried and tested methods. But, facing a challenge of producing 8,000 low income homes, the Government of Rwanda is also aware of the costs of getting this wrong. For instance, will poorly located projects increase transport subsidies and healthcare/education provision costs? If Kigali is to undertake a pilot incremental build project, it is important to identify what are the risk areas of this "learning by doing"? What can actually be replicable from international experiences, and what will require deeper analysis for the specific context? At what scale should risks be taken, and who should *bear* the risks inherent in the project?

Architects, economists, and policy-makers always need a **better understanding of the characteristics of housing demand, including the real preferences of recipients**. Almost all projects suffer for lack of this understanding, and many mistakes are implemented due to innocent but incorrect assumptions. For instance, studies indicate that location has stronger multiplier effects on wealth compared to housing quality, and that people are willing to trade-off housing quality for better access to jobs. Also, evaluations of housing projects indicate that follow-up to manage the *evolution* of the house and neighbourhood is at least as important as the delivery of the project itself. Community groups can be essential policy instruments, since they combine not only demand information, but also the capacity for appropriate social and technical innovation.

If the Rwanda Housing Authority will embark on an innovative pilot housing project, it should consider:

1. Empirical evidence shows that large-scale housing provision doesn't necessarily entail huge builds from day one. Large scale projects should be built in 'packages' and generate 'sub-neighbourhoods' and centers with different characteristics as they go. This also keeps neighbourhoods flexible to real demand, and supply responsive to lessons learned.
2. Incremental housing has proved capable of giving low income home-seekers what they cannot provide themselves: well-serviced land, infrastructure, and foundational structures for a sturdy and extensible house. They enable structures and additional housing support to be tailored to existing building systems and knowledge, and respect people's preferences.
3. Density is a public good. It benefits everyone, through opening up the possibilities of production at scale, ideas exchanges, and access to goods and services. Housing density is vital to economic productivity. As Paul Collier has said, "One of the reasons Africa is no able to make the needed transition to large-scale production is the form of its cities." But there is no universal "appropriate density". It depends on the overall economy of the city, the period in a city and neighbourhood's evolution, and the very close local context and conditions for the neighbourhood. History tell us that ***fictional densities*** **are as bad as very low densities**, and the undesired outcomes (poor safety, illegality, crime) can be even higher. The role of the state is to create sustainable neighborhoods and **facilitate the densification processes**. The state cannot create density in an area people do not strongly desire to live.
4. Land should be considered a development tool, and there should be a focus on creating Location- small centres within neighborhoods, for communities of houses, economic activity, public gatherings and so on. Asking what makes a good neighbourhood, rather than just a good house, at early stages in neighborhood design is critical.

5. Whether an incremental methodology is selected or not, a well-planned and carefully executed ***follow-up* of the project** is important for mid and long term success. However, this does not mean putting neighbourhoods in a straight-jacket. Standards -in both planning and architecture- should be perceived as a dynamic regulation tool, responsive to needs and uses that emerge. Furthermore, incrementalism is –in its essence- a trade-off option for achieving low income housing in a good location, and implies a mind-set change in terms of building standards and the speed of progress to 'polished' neighbourhoods.
6. **Access to finance** and savings capacity are crucial and often overlooked. People must be able to access and finance loans, on the plots or on their improvements, for incremental building to succeed. Likewise, knowledge about home maintenance and renovation is important, and the implementers should study current levels of knowledge, and means to strengthen these to required levels.

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