

LARGE SCALE SYSTEMS ENGINEERING OF HOUSING IN SINGAPORE

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Abstract. This paper examines how the Housing Development Board (HDB) of Singapore provides low cost housing in addition to achieving other social, economic and political goals. It uses the large-scale systems engineering framework to analyze these goals, the boundaries HDB has to maintain or overcome and the continuous improvements it had achieved. Finally it examines some of the lessons learnt and the challenges that HDB faces in the future. The human dimension of such an undertaking is especially important and will be highlighted throughout the paper.

Introduction

Two of the most critical issues facing Singapore in the early 1960s and after achieving independence were unemployment and housing. As a result, two government agencies were tasked with solving these problems - the Economic Development Board (EDB) and the Housing Development Board (HDB). EDB was placed in charge of solving the employment problem through large-scale industrialization while HDB tackled the acute housing needs by building more flats.

Remarkably, at the end of its first five-year building programme, the HDB had completed over 54,000 dwelling units. Up till now, about a million residential flats were built (HDB, 2008) for sale or rental and a substantial volume of related facilities, such as commercial spaces, light industries, shops and recreational facilities etc. were completed, all within comprehensively planned and self-sufficient high-rise, high-density new towns. Currently, more than 82% of the 3.5 million population (citizens and permanent residents) live in these flats (HDB Annual Report, 2008). This achievement was made possible by good economic growth and a set of judiciously applied policy decisions

In this paper, we will examine retrospectively how HDB manages such a feat using the large-scale systems engineering (LSSE) framework. We will first briefly describe the framework of LSSE and then focus on the goals and the boundaries and limitations including the complexities involved to understand the issues in planning, design and management of housing. Then, we will study some of HDB's efforts in continuous improvements and conclude by exploring some of the lessons learnt and challenges that HDB faces in the future with special emphasis on the human dimension of its undertaking.

Large Scale Systems Engineering Framework

Large Scale Systems Engineering deals with the complexities of large-scale systems. The large scale systems engineering framework defined here is “an extensible structure for describing a set of concepts, methods, technologies, and cultural changes necessary for a complete product design and manufacturing process” (CERN, 2001) of a large-scale system.

The underlying foundations of LSSE are conceptualization, systems engineering, and organizational learning.

Conceptualisation. One of the most difficult tasks in large-scale systems is conceptualization and this is one of the main emphases of LSSE. It is similar to the conceptual stage of the life cycle stages identified in ISO/IEC 15288, whose purpose is to identify stakeholders' needs, explore concepts and propose viable solutions. Apart from stakeholder' needs, defining the *goals* of the system is also very important. However, this is made much more difficult with multiple *stakeholders*, for 'planning is a component of politics' (Rittel and Webber, 1973). Perhaps more importantly, conceptualisation allows all constituencies to participate and work together towards accomplishing goals and allows the system to set priorities. In many ways, this is similar to a masterplanning or strategic planning process. Such processes in LSSE also examine possible unintended consequences of solutions.

Systems Engineering. The systems approach and systems engineering methodologies are also used to understand the key issues in the planning, design and management of large-scale systems. Master planning and system architecting are essential components of LSSE. Systems engineering tools such as Analytic Hierarchy Process (AHP), engineering economy and the cost-benefit approach are part of the analysis of large-scale systems. In addition, risk (especially enterprise risk) and safety management is addressed in large-scale systems. Systems engineering help to deal with the technical/ systems complexity of large-scale systems.

Organizational Learning. The systems engineering process is "iterative and supports learning and continuous improvement" (Haskins, ed., 2006). Similarly, learning and continuous improvements are important components of LSSE. The learning organization as espoused by Peter Senge (2006) provides the framework for learning as individuals and in teams. One of the five disciplines of the learning organization is systems thinking which is also an important component of systems engineering. Systems dynamics are tools used to analyze the *complexities* of large-scale systems for time and timing are important components in large-scale systems engineering. Time and delays cause *boundaries* to change, hence one cannot optimize a system all the time – robustness and resilience have to be built in. There is also a right time to introduce new concepts and to seek approvals as the right people has to be at the right time and place. The other disciplines of the learning organization are shared vision – the practice of unearthing shared 'pictures of the future' that foster genuine commitment; personal mastery – the skill of continually clarifying and deepening our personal vision; mental models – the ability to unearth our internal pictures of the world, to scrutinize them, and to make them open to the influence of others and; team learning – the capacity to think together which is gained by mastering the practice of dialogue and discussion (Senge, 2006).

The other aspect of organisational learning is lean thinking - "a way of thinking" to adapt to change, eliminate waste, and continuously improve. It helps integration across domains, disciplines and organizations and introduces new ways to view processes through innovation and breaking paradigms (Womack, Jones and Roos, 1991). It also adopts a long-term philosophy, which is important in large-scale systems as they are usually of long duration. Lean thinking integrates technology, processes and people and support constant reflection and improvements. Organization learning in LSSE helps to deal with the behavioral complexity of large-scale systems.

Using the approaches and considerations mentioned in the preceding paragraphs, LSSE examines the goals of a system, its stakeholders, and its boundaries and limitations including the complexities involved to understand the issues in planning, design and management of such large scale systems. In addition, the possible effects and unintended consequences are also considered. To do this, it draws upon some of the practices from engineering, businesses management and political and social sciences.

This paper will concentrate on four aspects of LSSE, namely, goals, complexities, boundaries and continuous improvements in the engineering of public housing for Singapore.

Evolving Goals and Complexities

Large-scale systems are often made of other smaller systems. While methodologies for eliciting and specifying requirements of the smaller systems are quite established, defining the goals of a large social system is more challenging in several aspects. First, the goals can be something less tangible and hence more difficult to translate to requirements. Second, very often the goals can conflict with each other. Third, the goals can change as the system evolves. Four, while goals can remain the same, the policies and requirements can change as the environment changes.

Goals are associated with the system's stakeholders. The two major stakeholders in public housing are the government and its citizens. We shall examine the goals of the system from the responsible party i.e., the government's perspective. Apart from providing housing, policies were also implemented through HDB to achieve certain desired (and often unstated) goals. These are:

- a. Affordability: Providing low cost housing.
- b. Stake in Nation: Encouraging nation commitment through home ownership
- c. Social Development:
 - i. Reinforcing the normal family and promoting the extended family
 - ii. Promoting racial and class harmony
 - iii. Discouraging welfarism
- d. Economic Development: Providing a disciplined workforce and shaping the economy
- e. Political Development: Promoting political support

Affordability: Providing Low Cost Housing. HDB was formed on 1 February 1960 as a statutory body responsible for Singapore's public housing programme to build low cost housing. The urgency of meeting the housing need meant building large numbers of flats quickly and at minimum cost. It was responsible for land acquisition, resettlement, town planning, architectural design, engineering work and building material production except the actual construction of the buildings, which is undertaken by private contractors. It was also charged with the allocation of flats both for sale and rental and the management of all aspects of the housing estates. In short, it was responsible for the total management of the public housing sector except for the setting of sale and rental prices, which are decided by the Ministry of National Development (Chua, 1991). With centralization of such resources and

power, the HDB was able to provide housing at substantially lower cost than comparable accommodation in the private sector. Affordability is also enhanced through a number of grants/ subsidies and the CPF Housing Scheme, which are described in the next section. The definition of affordability also changes with time.

Stake in Nation: Encouraging Nation Commitment through Home Ownership. The then Prime Minister of Singapore, Lee Kuan Yew, noted that people who own their houses maintain them and this promotes political stability and continuity (Lee Kuan Yew, 2000). Thus, the Home Ownership Scheme was introduced to give Singaporeans the opportunity to own an asset in their country, contributing to overall national stability. A home would give them a stake to defend Singapore (Lee Kuan Yew, 2000). The Central Provident Fund (CPF), (CPF is a compulsory savings scheme to provide financial security for workers during retirement or when they are no longer able to work), Housing Scheme was introduced in 1968 to allow flat applicants to use their CPF savings to purchase HDB flats, thus making it easier for them to own an asset in Singapore.

The Government's commitment to home ownership is evident from the periodical raising of the income ceiling for eligibility to purchase public housing, in step with the general economic growth, so as to include as many households as possible. The ceiling of S\$5,000 per household, instituted in August 1989 covered about 90% of all households in Singapore. This ceiling has since been raised to \$8000 per household and \$12000 if it is an extended family. The down payment for purchase of HDB flat was also reduced from 20% to 10% of the purchase price or market value, although applicants will have to make a minimum of 5% cash payment (HDB, 2006). Other measures such as CPF Housing Grants for Family and Singles were also introduced later to make it even easier to own a flat.

Moreover, a household is permitted to sell its flat after five years' occupancy to another, who is within the eligibility rules of the HDB, at a price that is agreed upon between themselves, The seller gets to keep the capital gains from the sale and, in turn, to apply for a new public housing flat. The seller is entitled to do this once. This resale mechanism has given the masses in Singapore an investment opportunity. It has also led many families to upgrade their homes, thus reducing overall construction subsidy because the larger-room type are subsidised at a progressively reduced rate. The upgrading in turn achieves filtering-down effect of the market mechanism in the housing sector, making ownership even more extensive (Chua, 1991).

Social Development: Reinforcing the Normal Family and Promoting the Extended Family. The provision of public housing is also used to shore up family institutions. Public housing was only available to family households. Previously, only single males of more than 50 years of age and single females of over 40 years - that is, those who are presumably never going to marry - were eligible to rent; and then only if they share with another person. Young single individuals were excluded then. To cater for the changing demographic profile and people marrying later, singles are allowed to buy a resale HDB flat if the person is more than 35 years old and has an income of less than \$3000 under the Single Singaporean Citizen Scheme.

Housing is used directly to support the family institution through a number of schemes: families of siblings or a married child and the family of his/ her origin may apply to be neighbours in order to maintain mutual support; these joint applicants are given priority of allocation, and the waiting time for their flats is reduced by as much as two years. In 1978,

three special schemes to encourage extended family ties were introduced - the Joint Balloting Scheme, the Mutual Exchange of Flats Scheme and the Reside Near Parent/Married Children Scheme. In 1982, the Multi-Tier Family Scheme was also introduced to encourage families comprising parents and their married children to live together under one roof. Furthermore, in addition to priority of allocation, the income ceiling for eligibility is raised by S\$8,000 to S\$12,000 for a young family which chooses to live with one of their parents.

Social Development: Promoting Racial and Class Harmony. Being the sole provider of public housing enables the HDB to further serve as an agent for the propagation of certain values that the state deems significant. For example, the housing programme has been used to break up minority communities, namely Malays and Indians, and communities of the different dialect groupings among the Chinese majority, remixing them in housing estates. This is deemed as necessary to pre-empt any possibility of race riots, last seen in Singapore in 1964. It is hoped that the dispersing and remixing all ethnic and dialect groups will lead to national integration.

The dispersion is achieved through (1) the first-come-first-served rule that governs the allocation of flats, and (2) maintaining a quota on minority population in every housing estate so as to prevent the development of ethnic enclaves. The race-mixing rules took on greater emphasis in 1989 when the Government noticed that substantial Malay households were regrouping in certain housing estates through the purchase of new and resale flats. Hence since then, in addition to maintaining the approximate proportional distribution of the three different ethnic groups in every new town, the ethnic composition of every block of flats is to be monitored. Where there is over-representation of a particular ethnic group, anyone in the block who wishes to sell a flat must sell it to a member of the ethnic group that is under-represented (Chua, 1991).

The same logic of national integration is applied to the mixing of classes. Class enclaves are dispersed by the planning process in which the rental flats for the lowest income groups are spread among the various classes of purchased flats. Thus each housing estate is a mixture of different-sized flats catering to different income groups. Income group mixing can be built into a block of flats itself, for example, four-room flats are mixed with five-room flats in a single block.

Social Development: Discouraging Welfarism. Care is also taken to preclude the possibility of housing becoming a legal entitlement of citizenship. For example, to assist those in the low income groups who might not be able to afford to purchase a flat, those households with incomes not exceeding \$3000 per month, would be given an additional housing subsidy when they buy a new or resale HDB flat. However, to be eligible, at least one of the flat buyers must also have worked continuously for 2 years (HDB, 2006).

Economic Development: Providing a Disciplined Workforce and Shaping the Economy. Resettlement into high-rise flats immediately raises the cost of living of a household. Home ownership ties the household into a regular mortgage structure that requires monthly payments. Both the cost increases and regular payments can be fed only by regular monthly income earned often by pooling the incomes of several members of the family. The encouragement of home ownership was therefore an important step in the active proletarianization of the Singapore population i.e. people move from being either an employer, self-employed or unemployed to being employed as wage labour by an employer while simultaneously improving their material living conditions, as the Government had

promised. Indicative of the underlying active transformation of the work-force is the steady decline in the unemployment rate from 6% in 1970, two years after the introduction of the CPF home ownership scheme, to 2.7% in 1984 (Krause, Koh and Lee, 1987:190). The jobs created yielded the savings collected through the CPF to pay of the housing. It was a virtuous cycle of jobs, savings and housing as shown in Figure 1.

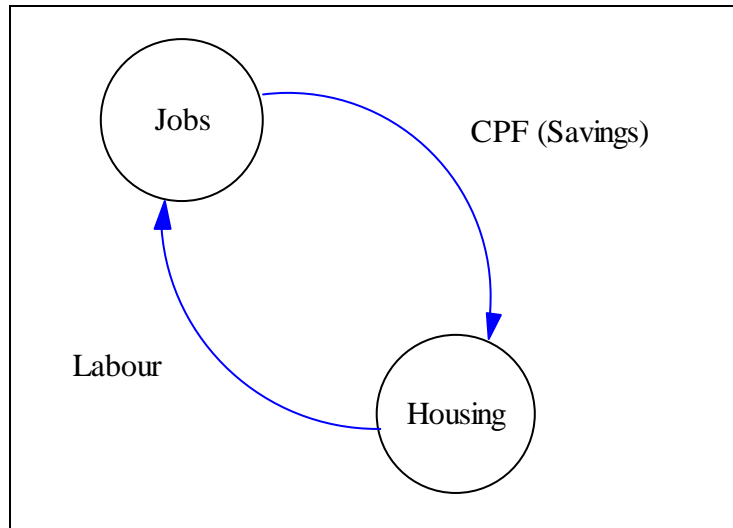


Figure 1. Reinforcing loop between housing and jobs.

Furthermore, housing estates were built near industries to tap the pool of young women and housewives. They provided over 150,000 jobs for more women than men, most living nearby; this helped to double or treble incomes as well as providing labour for the factories (Lee Kuan Yew, 2000).

Public housing kept operational costs low for multinational investors since cheaper public housing lowered the cost of living. By keeping rents and prices low, it relieved the pressure on wages without lowering the quality of labour. At the same time, another attraction for multinational investors was the fact that Singapore's public housing entailed planning and development of a complete network of urban infrastructure as well, such as provision of factory sites for light and non-polluting industries in the new towns and the construction of transport networks. It controlled inflation by controlling the housing supply and supply of financing through CPF contributions for house purchase. At the same time, when wages increased, CPF contribution rates increased, so that the net increase in wages is effectively reduced and spending power curbed (Perry, Kong and Yeoh, 1997).

Political Development: Promoting Political Support. The extensive public housing programme is symbolically, hence ideologically, a powerful sign of the existing regime's ability to fulfil its promises to improve the living conditions of the entire nation. The housing programme therefore gives the Government a very substantial measure of legitimacy among the people and abroad (Chua, 1991).

The goals discussed in the preceding paragraphs support one another and illustrated the complexities of public housing. For example, affordability encourages commitment and stability. This in turn promotes economic, social and political development, which in turn provides the environment for further growth and development as shown in Figure 2. We have

also showed that policies implemented to meet these goals evolved over time to meet the changing profile, needs and aspirations of the citizens. This will be further explained in subsequent paragraphs.

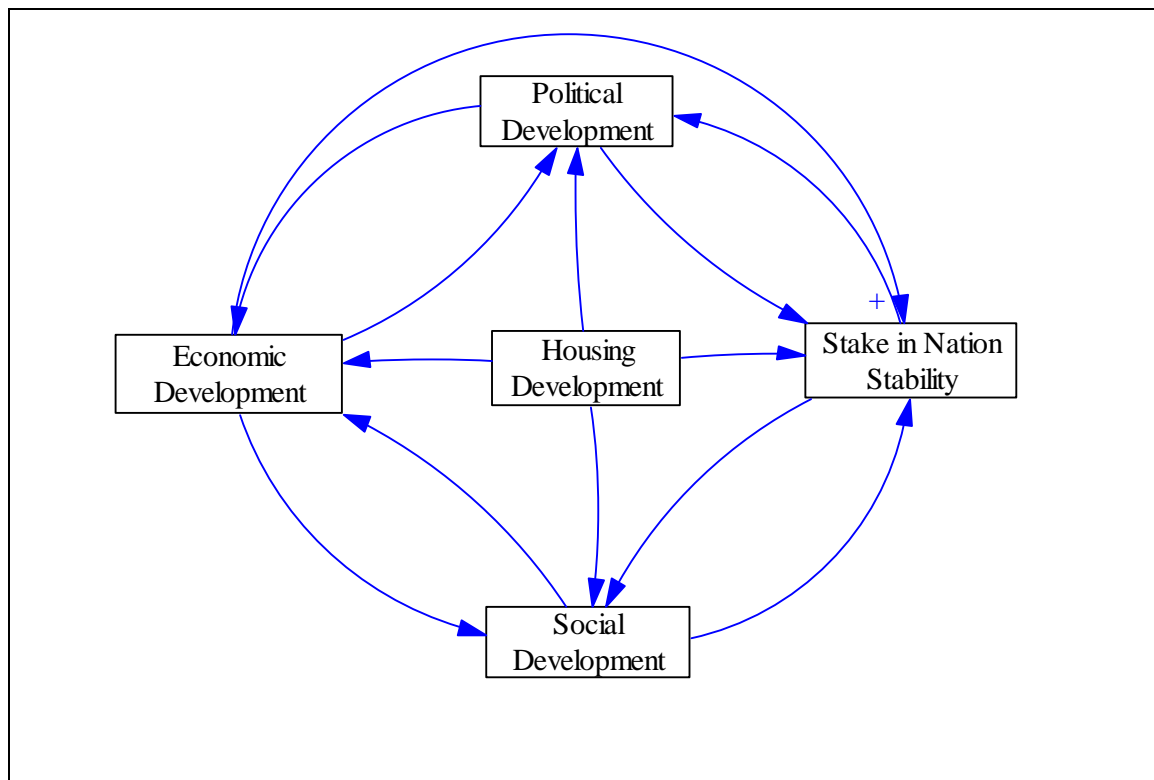


Figure 2. Causal Loop Diagram showing the relationship between goals.

Boundaries

Types of Boundaries. With a history of more than 45 years, time and timing are important considerations for HDB. Time causes boundaries to change, for example, HDB has to keep up with the changing aspirations of Singaporeans. Moreover, HDB has to time the introduction of new policies carefully to make it more acceptable. Hence, the goals for HDB evolve as these boundaries change:

- a. Physical – due to Singapore’s small size, she has to ‘build up’. Hence we can observe that the bulk of public housing are high-rise apartments. Although reclamation of land is being carried out to provide housing and other infrastructures, it is a slow process.
- b. Economic – the urgency of building cheap flats lead to only the barest amenities were provided. However, as the urgency subsides, occupiers are increasingly looking for better finishings and facilities.
- c. Social – the goals of promoting family ties and racial harmony and discouraging welfarism define who is eligible to apply for the flats and who gets subsidies. These boundaries are also evolving to suit current environmental conditions.

d. Political – it is sometimes perceived to be used as a political weapon through the denial or delay in providing certain privileges/entitlements to opposition political parties.

e. Private/public housing – apart from making housing affordable, this boundary serves to provide aspirations for Singaporeans to upgrade to private housing if and when they can afford it.

Meeting Changing Aspirations. HDB's objective in the early 1960s was to build low-cost housing for low-income Singaporeans to tackle the massive housing shortage. Moving into the seventies, it concentrated on improving housing standards and encouraging home ownership. In the eighties, it set out to build, not just homes, but communities in self-contained towns. In the nineties and beyond, the challenge is for HDB to respond to aspirations for a better quality lifestyle, one that will continue to remain affordable and innovative. The HDB of tomorrow faces new challenges as new housing needs will surface in the future - keeping up with the needs of a younger generation as well as caring for an aging society. In trying to meet the aspirations of flat owners, the HDB introduces a series of improvements throughout the years, some of these are:

a. To enable flat occupiers to own their flats, the Home Ownership Scheme was introduced in 1964. However, its impact was only felt after 1968, when the government announced that savings accrued in CPF accounts could be used to pay monthly mortgage instalments.

b. In 1971, HDB also introduced a new 5-room flat type which had a higher income ceiling than that for other flat types, to cater to Singaporeans' aspirations for bigger homes.

c. In 1979, the Executive flat type was introduced to cater to a new group of middle-income public housing applicants. Along with this, an income ceiling of \$3,500 was set for the Executive flats, while the income ceilings for 3/4-room and 5-room flat types were raised to \$1,500 and \$2,000 respectively.

d. In 1987, HDB also allows permanent residents to buy resale flats and HDB residents to invest in private residential properties.

e. In 1991, the pilot phase of the government's Main Upgrading Programme for older flats was launched. The Single Citizen Scheme and the Transitional Rental Housing Scheme were also implemented, to meet the housing needs of unmarried citizens and young couples waiting for their HDB flats to be built.

f. Design plus (upmarket flats designed by HDB architects to provide greater variety) and Design, Built and Sell Scheme (designed by private architects and engineers in partnership with contractors) were introduced. At the same time, mature estates are being upgraded with new facilities and major facelifts.

g. Town planning for new towns was continuously refined to incorporate new ideas generated and feedback from customers. Master plans for older towns were formulated to guide the rejuvenation process and implementation of Estate Renewal Strategy (ERS) programmes. The Estate Renewal Strategy (ERS) is an integrated and

systematic approach to renew older HDB towns and estates, and transform them to the standards of newer towns. Apart from renewal of physical environments under upgrading programmes, sites with potential for redevelopment were put to optimal use, and infused with a new lease of life under the Selective En bloc Redevelopment Scheme (SERS). The rejuvenation plans would also address the higher number of elderly in old towns, and attract younger residents through new public and private housing projects (HDB, 2006).

h. The Lift Upgrading Programme (LUP) enabled HDB residents to enjoy the convenience of direct lift access on their floors. Project LIFE (Lift Improvements and Facilities Enhancement for the elderly) was implemented in 1993 at selected 1-room HDB rental blocks with a relatively high concentration of elderly households. Besides fitting the flats with elderly friendly improvement features, HDB also provided facilities for Voluntary Welfare Organisations to set up Neighbourhood Links to give community-based care and support services to the elderly (HDB, 2006).

Unintended Consequences. Architecting housing for the masses bring its own problems as apart from ensuring the fit between different policies, sometimes HDB/ Government has to balance and compromise some of these policies especially when the economic, social and political boundaries change. This may give rise to less than optimal results.

a. Forced Acquisition of Land. Due to compulsory land acquisition for public housing, affected landlords were left either to accept their losses with altruistic generosity and recoup some level of self-esteem or face the losses with bitterness and alienation from the new government. The popularity of the Government's action among the overwhelming property-less electorate enabled it to bear the rejection of this very small minority. There is evidence that the attitude of those affected by resettlement changed from resentment and resistance in the early years of the public housing programme (Gamer, 1966) to one of resignation, even acceptance, on the basis that everyone in squatter areas throughout Singapore was affected "equally" and that the land was necessary for the housing of the nation (Aldrich, 1985).

b. Inequality. "Although we mixed the races by making them ballot for their flats, we found that they were collecting together again. When owners sold their flats and were able to buy resale flats of their choice, they soon re-congregated. This forced us in 1989 to put percentage limits (25% for Malays, 13% for Indians and other minorities per block) beyond which no minority family can move into the neighborhood. This quota limited the pool of buyers for certain resale flats and so depressed their prices. When a Malay or Indian is not allowed to sell to a Chinese because the Chinese quota has already been filled, smaller numbers of Malay or Indian buyers were not able to pay the higher price which the Chinese majority can. However this is a small price to pay for achieving the larger objective of getting the races to intermingle" (Lee Kuan Yew, 2000).

c. Exclusion. The eligibility ceiling elicited complaints in the Press from the excluded group. The latest policy change to allow every household, regardless of income, to buy resale flats effectively removes some of the grounds for dissatisfaction with the Government's housing policy. There is, however, one constraint attached to this opening up of the opportunity for all to own public housing flats: the owner must live in the dwelling unit and not hold it as investment rental property. This restriction

is likely to discourage those high income households who view housing as status consumption as much as necessary shelter (Chua, 1991). Since 2005, flat owners were able to sublet their whole flat if they had occupied it for 10 years or 5 years if they did not have any outstanding HDB loans (HDB, 2006). Perhaps this is a political move so as not to alienate the higher income group of citizens.

d. Effects on the Private Property Market. Several initiatives were introduced to ensure HDB policies were more in line with the private property market:

i. In 1987, differential pricing policy for HDB flats was introduced. Under this policy, flats with location advantages would be sold at higher prices while those in less favourable locations would be sold at lower prices.

ii. In 1992, the first building contract under the Design & Build Scheme was also awarded to private firms, signalling the start of private sector involvement in public housing projects.

iii. Significantly, even with its goal of 100% home ownership, the Government has not until recently abolished the income ceiling for eligibility, although logically this would be the popular thing to do. While there may supply and subsidies issues, it is possible that the reasons for not lifting the income ceiling are (1) to protect the private housing market where Singaporeans and foreigners have invested very substantial amounts, and (2) to keep private housing as a socially differentiated housing class (Chua, 1991). However, in August 1989, the income ceiling was removed for the purchase of resale flats, though the \$8000 ceiling remains for the purchase of new HDB flats. Apart from perhaps ameliorating the upper income group, the quality of certain categories of HDB flats is comparable to the private sector. Indeed, the prices of high end HDB flats are on par with some of the lower end private housing. The boundary between public and private housing is blurring.

iv. The government, which owns 70 per cent of Singapore's land, is the state's biggest property owner and developer. If it brings down HDB prices, it will impact the whole property market and wipe out the value of the biggest assets among Singaporeans. HDB prices form a psychological price tier of Singapore's housing pyramid. Any price cut would spill over to the private sector and eventually have an impact on the assets of its citizens. This may have undesirable effects on the prices of property in Singapore.

Continuous Improvements

We have illustrated how the HDB has evolved its policies as the boundaries change to meet its goals. We have also shown that such endeavours could be difficult and may have unintended consequences. Nevertheless, HDB continues to improve its processes, practices and services.

Building Service Centres. For example, Building Service Centres (BSCs) were set-up on site at newly completed housing projects to facilitate flat dwellers' surfacing of defects in their flats for HDB's attention. A BSC would be in operation for six month from the completion of the precinct. Where previously flat owners had to surface defects to the branch

offices in-charge of the flats, the new on-site service made it convenient for HDB to assist flat owners in inspecting, investigating, and repairing defects. BSCs were also equipped with a monitoring system that tracked defects reported, ensured building contractors' prompt response and work carried out. The system also recorded residents' surveys for service improvements, with data collected and analysed to improve design and construction for future projects (HDB, 2006)

Building Materials. HDB also continues to improve in the materials and techniques used in building flats. Such improvements lead to cost savings and improved safety (HDB, 2006):

- a. In response to the need for safer windows in housing estates, HDB introduced Catch 21T, an innovative friction stay design that provided an additional safeguard against falling windows.
- b. The Spiral Connector, an efficient connection system for precast components won the HDB Innovation Award 2005. The innovation reduced the cost of precast connection by as much as 50 percent without compromising safety and reliability.

HDB also played a key role in leading the construction and real estate industry towards environmentally sustainable development, through planning, design, pre-construction and post-construction phases. The Committee on Environmental Sustainability (CES) of HDB Estates was formed to enable HDB to play a proactive role in promoting and implementing environmental best practices and values (HDB, 2006).

Eco-Friendly. HDB had over the years increased green spaces in its estates by introducing better landscaping, more neighbourhood parks and green connectors. HDB also looked into the introduction of extensive green roof systems on the roofs of its residential and Multi-Storey Car Parks (MSCPs). Even though such green solutions were mostly catered for temperate countries, HDB successfully developed and patented a portable extensive green roof tray system (HDB, 2006). It is building an eco-precinct project called [Trelodge@Punggol](#) which will feature technologies and innovations such as green balconies, solar panels to generate energy for lighting in common areas, centralised refuse chutes for recyclable waste and a rainwater collection system (MEWR, 2008).

Uniqueness. In its “Remaking Our Heartlands” project, plans have been drawn up to “further improve the physical environment of HDB estates, plans tailored to meet the changing needs of an ever-evolving community. Each estate will build on what makes it unique as location, geography and features get played up - to capitalise on each area’s distinct personality and make it endearing.” (HDB, 2008)

Lessons Learnt

To continuously improve, an organisation must be able to learn the lessons from its mistakes. HDB continues to finetune its policies based on the lessons learnt. Examples of some of the lessons learnt are:

Living Adjustments. Initially, the People Action Party (PAP) did not gain full support for the building of HDB flats. The new HDB residents had problems adjusting (Lee Kuan Yew, 2000):

- a. Resettlement of farmers and others from almost rent-free wooden squatter huts with no water; power or modern sanitation, and therefore no utility bills, into high rise dwellings with all these amenities but also a monthly bill to pay. “It was a wrenching experience for them in personal, social and economic terms.”
- b. People reared pigs, chickens and ducks in their flats and planted vegetables around the flats.
- c. For a long while they walked up the stairs because they were afraid of lifts and continued to use kerosene lamps instead of electric bulbs.
- d. Others continued their small businesses as before, selling cigarettes, sweets and sundry goods from their front rooms on the ground floor.

Fifteen to 20 years after been resettled in HDB new towns, many still voted against the People Action Party. They felt the government had destroyed their way of life (Lee Kuan Yew, 2000).

Loans. HDB offered housing loans in 1964, at a low interest rate with repayment periods up to 15 years, but the scheme did not take off. Prospective buyers could not raise the down payment of 20% of the selling price (Lee Kuan Yew, 2000). It was only the introduction of the CPF Housing Scheme in 1968 that home ownership took off.

Workmanship. During 1982-84, the poor workmanship resulted in considerable cost bored by HDB to rectify the defects that had also caused great convenience to the homeowners (Lee Kuan Yew, 2000).

Demand and Supply. A strong economy provides high CPF savings and this had led HDB to overbuild. The Asian financial crisis in the mid 1990s led to a sharp and sudden fall in demand, particularly those who were hoping to make money by upgrading. The HDB was left with unsold flats, some 17000 units then. As of 2005, there are some still 10000 flats lying vacant (Ngiam, 2006).

Upgrading. With falling housing demand, the HDB was asked to embark on what is now known as the interim and main upgrading programme. When first conceived, the clear intention was for the lessee to pay 50% of the cost. But to qualify for these upgrading schemes, there needed to be a 75% majority to vote for upgrading. To secure the vote, the share of the lessee was reduced from 50% to nearer 20% to obtain the mandate to upgrade. Even then, in one or two polls in recent years, the HDB could not secure the 75% majority to proceed. The reason was simply that the increase in the resale value of the flat after upgrading has of late been less than the cost of upgrading (Ngiam, 2006).

Challenges

Challenges exist in all large-scale systems engineering and many of the challenges in engineering housing are associated with people. Ahead, the task of sustaining the drive of the population - when the basic necessities are already satisfied and when incremental material improvement is no longer the sole criterion for assessing public policies - is increasingly an uphill battle. The boundaries have changed again. Some possible future problems are:

- a. A declining birth rate and with almost nine-tenths of the people properly housed, the public need for HDB apartments has declined substantially through the past decade.
- b. The public taste has changed. The younger generation does not just want a subsidised flat like their needy parents. It wants one in a choice area comparable to some of the high standards of a private condo. As society develops, the HDB has to cater for different needs of different people, the middle class and the poor. It also has to keep up with advancing design, technology and higher costs.
- c. Singapore's aging population introduces new problems as many of the flats were built for the young and healthy. Several initiatives have already been introduced, such as lifts for every floor, but such problems are likely to become more acute in later years.

Conclusions

Singapore has come a long way from 1960 when the HDB was first established to deal with the massive problems of overcrowding and unhygienic conditions in slums and quarters. For the last four decades, HDB has worked to provide Singaporeans with a living environment that is the envy of many. Home ownership has been achieved to a very large extent, and an HDB flat remains, for most Singaporeans, the biggest asset that they have. For this, HDB received the United Nations Public Service Award for its Home Ownership Programme in Jun 2008.

The HDB has played a key role in nation building, in terms of commitment and economic development. Housing policies have supported the institution of the family and encouraged ethnic integration. It has also strengthened the political legitimacy of PAP. There were important lessons learnt but overall HDB/ Government has done an excellent job. Having met largely its goals in the past, the future role of HDB will not be easy. Hopefully through the use of systems engineering, it is able to continue to meet the goals the government has set for them.

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