The Only Way to Build is Upwards: The Tallest Public Housing Development Project in Singapore

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Abstract

Singapore, whose land area is approximately 660 square kilometres, is one of the most densely-populated cities in the world. Although land reclamation efforts have gradually increased the land size of the island-city-state, this approach to resolve the problem of land scarcity has its limitations. In the 2001 review of the Concept Plan, the Urban Redevelopment Authority of Singapore (URA) has estimated that Singapore would have a projected population of 5.5 million by 2040. This translates into 800,000 more homes or 6,400 ha of land that is needed to meet the demand for housing. Taking into account the other competing demands for land resources, the Concept Plan 2001 has suggested constructing taller buildings. With 85% of Singapore's population residing in public housing, the Housing and Development Board (HDB), being the largest provider of housing in Singapore, has initiated the development of new 50-storeys public housing in August 2001. The 50-storeys public housing development, which consists of more than 2,000 dwellings, is the first of its kind in Singapore. This paper provides an insight into the potential residents' perception, attitudes, concerns and acceptability of such a high-rise high-density housing development which has features that are similar to the concept of a vertical city. Findings reveal that despite being accustomed to four decades of high-rise, high-density living, only 42% of Singaporeans would choose to live in such super high-rise dwellings. Younger and smaller households are generally more receptive towards this new housing form, while males are more likely to favour this type of housing than their female counterparts. The main attractions of such high-rise housing developments are highlighted as the scenic view and windy environment in contrast to the major concerns such as pricing, safety of the building structure, insufficient provision of facilities and amenities, as well as traffic congestion. The findings of this paper have important implications for policy-makers, government authorities, planners and developers, especially in congested cities where land is a major constraint and the only way to build is upwards.

Keywords: High-rise, public housing, residents' perception, vertical city, Singapore.

Introduction

With a land area of only approximately 660 square kilometres (Urban Redevelopment Authority, 2001), Singapore faces a massive challenge to manage the problem of land scarcity. Throughout its history, Singapore has sought to resolve this problem through land reclamation. However, this method of land expansion has its limits, both technically and geographically. Thus, according to the Urban Redevelopment Authority of Singapore (URA) in the 2001 Concept Plan, land reclamation efforts in the future are likely to increase the existing land area by only another 15% (Urban Redevelopment Authority, 2001).

The Concept Plan 2001, which maps out Singapore's urban development for the next 40 to 50 years, is based on a population scenario of 5.5 million. This projected population size would require another 800,000 homes in addition to the existing 1.0 million homes (Urban Redevelopment Authority, 2001). In view of this, URA's proposals for housing developments in the future have inevitably included taller and higher-density developments as well as more innovative and experimental housing forms so as to accommodate the population growth (Urban Redevelopment Authority, 2001). The concept of a vertical city (for example, Le Corbusier, 1946 & 1947; Soleri, 1970 & 1996; Takenaka Corporation, 1998) may be just the solution to Singapore's problem of land scarcity.

With 85% of Singapore's population residing in high-rise public housing that are constructed by the Housing and Development Board (HDB) since 1960 (HDB, 2001), the public housing sector offers immense potential and a better-controlled environment in which to start implementing the innovative housing proposals of the 2001 Concept Plan. Thus, when the government announced the redevelopment plan for Duxton Plain in August 2001 (The Straits Times, 17 August 2001), the proposal was to construct a 50-storeys high-rise high-density public housing development, which would consist of more than 2,000 dwellings. Although high-rise living has always been the norm in land-scarce Singapore, and some of the more recent public housing developments constructed in the early 2000's are towering at 30-storeys and 40-storeys high, the proposed 50-storeys public housing development at Duxton Plain is still the first of its kind in Singapore.

The public housing programs in Singapore are basically government-initiated with minimal input and feedback from residents. However, since buildings are utilised by people and the latter's reaction to the built environment have important implications for policy decision-making (Beedle, 1979), it is the intention of this paper to examine potential residents' perception and attitudes towards the first 50-storeys high-rise high-density housing development in Singapore, their concerns and acceptability of this new housing form, which comprises some elements of a vertical city, as well as what features attract or deter them from living in such dwellings.

After this introductory section, the second section is a brief review of the literature on the concept and features of a vertical city as well as residents' adaptation to and perception of high-rise high-density living. The research design and methodology are highlighted in Section 3 and salient findings are discussed in Section 4. Section 5 concludes with a discussion on the implications of the research findings.

Literature Review

The concept of a vertical city was first developed in 1922 by Le Corbusier (1946 & 1947) who proposed a plan where three million people would be housed in a specially designed "contemporary city". This notion of a vertical city was Le Corbusier's (1946 & 1947) first systematic attempt to design an environment in which man, nature and machines could be reconciled. The main features of Le Corbusier's 1922 vertical city consist of very high-rise high-density skyscrapers which leave at least 85% of the ground free for open space and other recreational facilities; an elaborate but well-coordinated system of vertical transportation comprising elevators that serve as superhighways, subways, access roads and pedestrian walks; as well as a very large population of people who would work and live within the skyscrapers (Le Corbusier, 1946 & 1947).

In 1956, another version of a vertical city, the "Illinois", was designed by Wright (Frank Lloyd Wright Archives, 1994). "Illinois", which is a mile-high skyscraper with 528 storeys, could accommodate up to 100,000 people, parking for 15,000 cars, and even enough office space to house the entire state government (Frank Lloyd Wright Archives, 1994).

Expanding on Wright's ideas which date back to the 1950's, Soleri (1969) developed the concept of "arcology" which means a harmonious combination of architecture with ecology. Soleri's (1969) first vertical city plan was "Babels". "Babels" was intended for a population of 520,000. It included an underground industrial and commercial area, with the city centre, neighbourhoods, parks, community areas and housing located at the very top of the structure. In the design of "Babels", horizontal transportation networks have been minimised to prevent urban sprawl as well as damage to the environment by smog and pollution.

Another vertical city design developed by Soleri in 1970 was "Arcosanti" (www.arcosanti.org, 2003). As the buildings in "Arcosanti" are of mixed-use, with residential, retail, office, recreation and services all located within the same structure, each building is self-sufficient. The "Arcosanti" concept is envisioned to be a prototype vertical city, which promotes energy conservation, human interaction, and a creative environment while minimising automobile transportation. Efforts of construct "Arcosanti" have resulted in completing only 3% of the project since its inception in the 1970's (The New York Times, 26 July 2001). Upon completion, "Arcosanti" is likely to occupy 15 acres of land with buildings 25-storeys high, and house approximately 7,000 people (www.arcosanti.org, 2003).

In more recent times, the proposals of vertical cities include the self-contained one kilometre cube "Hyper Building" designed by Soleri in 1996 for Japan (http://www.arcosanti.org, 2003), Takenaka Corporation's 1989 Sky City 1000 concept "Holonic Tower" (www.takenaka.co.jp/takenaka_e/superhigh/2skycity/skycity, 2003), the 170-storeys high "Millennium Tower" of Tokyo which is self-sufficient and could even process its own waste (www.fosterandpartners.com, 2003), as well as the innovative "Ultima Tower" by Tsui Design and Research Inc (1991) which has been specially planned for building in the middle of a lake so as to ensure a constant supply of fresh water, and a cooling system for the structure (www.tdrinc.com/ultima.html, 2003). All these super high-rise high-density vertical cities are

designed to enable the city to grow vertically rather than horizontally, thus promoting highly efficient land usage, while at the same time, alleviating traffic congestion and commuter rush problems.

Although many urban planners and architects advocate the vertical city concept as a solution to land scarcity, urban sprawl and environmental damage, very few studies have been conducted on the needs, perception and reaction of the residents, basically because many of the plans highlighted above have remained as theoretical concepts due to constraints of technology and budget. As such, the existing literature comprises largely studies carried out on the residents or potential residents of normal tall buildings (for example, Herrenkohl et al., 1981; Beedle and Rice, 1991; Haber, 1992; Council on Tall Buildings and Urban Habitat, 2001), where they examine issues such as the residents' preferences and needs (Haber, 1992) as well as the relationship between the residents' acceptability and their previous experience of living in a high-rise development (Herrenkohl et al., 1981).

In the context of Singapore, HDB has conducted several studies to assess the residents' acceptability of living in high-rise public housing (HDB, 2000). In addition, Lim (1994) observes that the population in Singapore has gradually accepted the high-rise lifestyle. The percentage of residents willing to live on the 10^{th} floor and above has gradually increased from 27.9% in 1973 to 35.7% in 1977, and to 47.3% in 1981 (Lim, 1994).

In terms of the psychological and social aspects of living in high-rise housing, Young (1976) suggests that high-rise living could be detrimental to the creativity and physical development of young children due to the constraints of play activities and facilities. It is also noted that health problems such as respiratory infection have been more prevalent among women and children living in high-rise buildings. Although there is no clear correlation between the incidence of mental disorder and high-density urbanization, higher-density developments have tended to reduce social contact and community interaction between high-rise residents (Young, 1976; HDB, 2000).

With regards to environmental factors such as ventilation, noise and thermal comfort, Lim (1994) finds that these are generally acceptable in Singapore's high-rise public housing. As high-rise buildings tend to be tall and narrow, they should be designed such that when subjected to strong winds, the vibrations should not become unacceptable in terms of serviceability and safety (Balendra, 1993).

A view offered by a high-rise dwelling has been found to command a price premium (Rodriguez and Sirmans, 1994; The Straits Times, 11 March 2000; Lee, 2001) such that the view is in fact regarded as an amenity within the housing unit. With the application of hedonic models, Benson, Hansen, Schwartz and Smersh (1998) even differentiate the quality of the view, where "good" and "bad" views could lead to a difference in prices of between 8% and 20%. With only 0.2% or approximately 7,000 housing units in Singapore being located at the 25^{th} storey or higher, the prices of these dwellings have been found to escalate exponentially with its height, resulting in hefty premiums being paid for these high-rise units (The Straits Times, 11 March 2000). According to HDB's figures (The Business Times, 16 June 2001), dwellings on the top two floor levels of the pioneer batch of 40-storeys public housing blocks in Toa Payoh are priced between

12% to 15% higher than those units located on the first 20 storeys within the same building. This price differential translates to an average of S$31,000 to S$41,000 more.

Research design and methodology

Drawing from the literature review, a list of positive and negative determinants that affect residents' perception towards high-rise high-density living has been collated to form the main focus of the questionnaire survey. In addition to the respondents' household particulars and current housing details, they are asked to give their opinions on each of the factors based on a 5-point Likert scale, where 1 represents "very unattractive" and 5 means "very attractive". In June 2002, a total of 443 valid questionnaires have been completed out of 500 responses from a random sampling of potential public housing residents. The sampling has been conducted at the sales office of HDB, which is the official designated location for the sale and allocation of newly completed public housing units. Face to face interviews have been carried out, and where necessary, language translations are provided so as to ensure that the respondents fully understand the questions asked.

The data collected are analysed using SPSS Cross-tabulations to compare the association and correlation between two variables, where the confidence level applied in this study is 95%. In addition, the Binary Regression Model is employed, using "E-views" statistical tool, to examine whether potential residents wish to live in such a 50-storeys high-rise high-density public housing development.

Analysis and results

(a) Acceptability of the vertical city concept, in particular the 50-storeys public housing development at Duxton Plain

When the Singapore government announced plans to construct a 50-storeys high-rise high-density public housing development at Duxton Plain in August 2001, and when the design details were finalised in April 2002, the concept of a vertical city has been receiving wide publicity through the media. Despite the extensive publicity given to this project, when this survey was conducted in June 2002, it is found that only 50.8% of the respondents are in favour of the 50-storeys public housing development (Table 1), and of these respondents only 42.1% would choose to live in such a high-rise high-density development. As this high-rise high-density public housing development will only be completed in 2007, and hitherto the population has no prior experience with living at such heights, potential residents are still rather apprehensive and express their hesitation to accept this concept. Further analysis reveal that the respondents' level of acceptability of the 50-storeys public housing development is highly dependent on whether they wish to live in such housing (Table 2). Another interesting observation is that some respondents' (9.6%) exhibit a "not in my backyard" attitude where they may accept or agree to certain policies or concepts as long as the latter does not affect them personally (Table 2).

Table 1. Acceptability of the vertical city concept

Acceptability of the vertical city concept	
Favours vertical city concept	50.8%
Does not favour vertical city concept	49.2%
	100.0%
Given a choice, would prefer to live in a vertical city	42.1%
Given a choice, would prefer not to live in a vertical city	57.9%
	100.0%

Source: Author's survey.

Table 2. Relationship between acceptability and choice

		Choice		Total
		No	Yes	
Acceptability	No	48.3%	0.8%	49.2%
	Yes	9.6%	41.3%	50.8%
Total		57.9%	42.1%	100.0%
Correlation coefficient		0.8046		

Source: Author's survey.

(b) Profile of potential residents of the 50-storeys high-rise high-density public housing development

In this section of the analysis, the profile of potential residents who choose to live in the 50-storeys high-rise high-density public housing development is examined. In this instance, the dependent variable *y* may assume only two values, which are represented by "0" for "no" and "1" for "yes". As the fitted value of *y* from a simple linear regression is not restricted to lie between zero and one, a normal regression model is not suitable. Instead, a binary regression model is employed since it is designed to handle the specific requirements of two dependent variables only. Binary regression models could be fitted using either the Logistic Regression procedure or the Multinomial Logistic Regression procedure. For the purpose of this study, the Logistic Regression procedure is applied to produce the predictions, residuals, influence statistics, and goodness-of-fit tests using variable x data, which consist of the characteristics of the respondents, including their gender, age, educational level, income level, and their current housing details. In addition, a "Probit" model is employed to reflect a standard normal distribution for the regression. As the interpretation of the coefficient values tends to be complicated by the categorical and qualitative nature of the x variables, the discussion focuses on the sign of the coefficient and the probability figures rather than on comparing their degree of impact. The sign of the coefficient indicates the direction of impact, while the probability shows the likelihood of a variable occurring.

The results indicate that the respondents' decision whether to live in a high-rise high-density housing development is strongly influenced by their household size (Table 3). The negative coefficient infers that the larger the household size, the less willing is that household to live in a super high-rise building. In addition, the findings reveal that younger respondents, males and those who are currently living at higher levels tend to be more in favor of such high-rise high-density housing than older people, females and residents of lower-level dwellings. To a lesser extent, respondents currently living in larger dwellings as well as having higher monthly incomes and higher education tend to be more inclined towards super high-rise living.

Table 3. Binary probit regression of housing choice by profile of respondents

Variable	Coefficient	z-Statistic	Probability
C	1.43592	2.15872	0.0309
Gender	-0.40845	-2.28420	0.0224
Age	-0.16810	-3.22923	0.0012
Highest education attained	0.00774	0.07262	0.9421
Monthly household income	0.05093	1.00559	0.3146
Current housing type	0.08987	1.12753	0.2595
Storey/level of current home	0.03195	1.66371	0.0962
Household size	-0.24796	-3.53369	0.0004
Mean dependent variable			0.42083
Standard error of regression			0.46485
Sum squared resid			50.13099
Log likelihood			-144.17810

Source: Author's survey.

Note: The larger the absolute figure of the z-statistics the bigger the role a variable has in the model.

(c) Determinants of respondents' decision whether to live in a super high-rise housing development

Having derived the profile of potential residents of the 50-storeys high-rise high-density public housing development in Duxton Plain, the next stage of the analysis examines the "push" and "pull" factors that affect their decision whether to live in such a high-rise building. In the survey, the respondents rank each determinant using a 5-point Likert scale where 1 represents "very unattractive" and 5 indicates "very attractive" for "pull" factors, and 1 represents "very concerned" and 5 means "very unconcerned" for "push" factors.

From the results, it is obvious that the major attraction of super high-rise living is the scenic view (Table 4). With this factor's probability value being estimated at zero, it could be inferred that almost all potential residents who wish to live in a super high-rise building are generally attracted by the view. Another interesting observation reflects a misconception by many respondents who perceive higher floor dwellings to have a quieter environment (Table 4). On the contrary, the noise level is likely to increase at greater heights basically because sound travels upwards, more households are being housed within the higher-density development, and more traffic is generated as a result of more households. Traffic flow has been found to be the main component of noise in public housing estates, especially during the evening peak hours (Lim,

1994). Therefore, instead of providing a quieter environment, noise may be a major problem for the 50-storeys high-rise high-density public housing development at Duxton Plain.

Table 4. Binary probit regression of housing choice by determinants

Variable	Coefficient	z-Statistic	Prob.
C	-7.43695	-7.05945	0
"Pull" factors - Better view	0.99209	4.64429	0
Fresher air	-0.69795	-3.19419	0.0014
More windy	0.39907	2.13789	0.0325
Quieter environment	0.39267	2.77373	0.0055
High-rise living as a lifestyle	0.22607	1.11020	0.2669
Better quality of housing	-1.89E-01	-0.89080	0.3730
"Push" factors - Safety of the building structure	-0.09562	-0.69031	0.4900
Ease of escaping in emergency	6.98E-01	3.82720	0.0001
Longer waiting time for lift	0.14815	1.75151	0.0799
Lack of community interaction	0.36624	2.69316	0.0071
Insufficient supporting facilities	-0.13319	-1.09403	0.2739
Greater danger of high-rise littering	-1.94E-02	-0.16248	0.8709
Personal fear for height	0.27592	2.81853	0.0048
Higher pricing	-0.10476	-0.82111	0.4116
Mean dependent variable			0.42083
Standard error of regression			0.34724
Sum squared resid			27.12906
Log likelihood			-88.15575

Source: Author's survey.

The windy environment at higher floor levels is another strong "pull" factor that attracted potential residents (Table 4). In contrast, high-rise living as a lifestyle and whether such high-rise developments are of better quality are both not considered convincing "pull" factors by the respondents. Out of the range of "pull" factors, fresher air is observed to have a negative coefficient and a probability of 0.0014, which indicate that although many respondents may not wish to live in high-rise buildings, they are however attracted by the prospect of fresher air at the higher floor levels.

With regards to the list of "push" factors, respondents appear to be least concerned with the difficulty of escaping in times of emergency as they generally display great confidence in the safety provision for housing in Singapore (Table 4). Another "push" factor that is not regarded by respondents as a crucial concern is the psychological fear of heights since it is only natural that those who have this height phobia would not wish to live in a high-rise building. The lack of community interaction is also not likely to deter potential residents from living in super high-rise developments because many of them are already accustomed to the minimal neighbourly interaction, which is a consequence of the high-rise lifestyle in Singapore. The time needed for vertical travel within the super high-rise building does not appear to be a major concern to the respondents essentially because of the availability of modern technology as well as more efficient and speedier elevator systems.

The main "push" factors that pose as deterrents include pricing, facilities and safety issues. Despite the fact that residents are generally willing to pay sizable premiums for higher floor dwellings (The Straits Times, 11 March 2000), housing is likely to remain price-sensitive, especially during times of recession and excess supply. Although respondents are concerned over the adequacy of facilities, they are confident that HDB would make sufficient provisions for the mega 50-storeys high-rise development at Duxton Plain. As for safety issues, some aspects are part of the hazards of high-rise living such as high-rise littering, and as such residents would probably have to be educated on these issues.

(d) Preferred floor level and preferred number of floor levels in a public housing block

In terms of the respondents' preferred floor level, it is observed that the most popular floor levels are between 16 and 20 storeys (Table 5). Majority of the respondents (51.9%) prefer to live on the first 20 storeys and only 10% are willing to live above 40 storeys. This result suggests that after being accustomed to the floor level of their current dwellings which are typically up to 20 storeys high, most residents are generally resistant to change, especially when it is for an option that is unusual or unprecedented.

Table 5. Respondents' preferred floor level

Preferred floor level	%
5 & lower	5.4
6 to 10	15.0
11 to 15	13.2
16 to 20	18.3
21 to 25	11.7
26 to 30	15.4
31 to 35	6.7
36 to 40	4.3
41 to 45	3.7
46 to 50	4.2
51 & above	2.1
Total	100.0

Source: Author's survey.

With regards to the preferred number of floor levels a public housing block should have, majority of the respondents suggest a building height of between 30 to 35 storeys, with a mean of 34 storeys. As the new public housing blocks that are currently being built are between 30 to 40 storeys high, it appears that the public housing residents in Singapore have accepted this building height but are not yet willing to experience new concepts such as super high-rise buildings and vertical cities. Nevertheless, the population in Singapore would gradually accept the super high-rise buildings and vertical city concept as a way of life just as the previous generations of public housing residents have gradually accepted higher-rise living over the years (Lim, 1994).

Conclusion and Implications

As the concept of super high-rise buildings and vertical cities is still rather new to the population in Singapore and the first of such a housing development will only be completed in 2007, it is not inconceivable that only half of the potential residents are in favor of such a new housing form and even less people choose to live in it. The policy implications of this finding are likely to be in the realm of public education, feedback and participation so that the level of public awareness and acceptability could gradually be raised. As the new housing form appears to be more popular among the younger and smaller households, the public education efforts carried out should place more emphasis on the older and larger households.

With the scenic view and windy environment being highlighted as two major attractions of high-rise living, planners, developers, government authorities as well as policy decision-makers should ensure that these important "pull" factors are incorporated into the designs of their developments so as to attract more households to reside at higher floor levels, while at the same time being able to command a price premium for these features. However, from the perspective of potential residents, a primary concern is the exorbitant pricing of the super high-rise dwellings. A balance must therefore be achieved by policy decision-makers to ensure that pricing of such high-rise high-density developments remains affordable to the target households while simultaneously introducing new financing packages and instruments that would facilitate home-ownership of these new forms of housing.

On the other hand, the dual problems of noise and safety at higher floor levels would tend to be aggravated by the larger number of households and heavier traffic flow as a result of the higher density. The policy implication is that newer building materials, modern technology and more innovative acoustic and construction methods are likely to be explored to try and alleviate some aspects of these issues so as to make high-rise high-density living more acceptable and sustainable in the long term.

The public housing residents' preferred floor level and the number of levels within a public housing block have increased significantly compared to their perception in the past. It took HDB less than 10 years to transform unsanitary, slum-condition housing into high-rise dwellings, and only about four decades to super high-rise high-density vertical city developments. Past literature has shown that Singaporeans have been very adaptable to new housing forms. It is therefore likely that before long Singaporeans would also become accustomed to the vertical city concept. This inference bodes well for planners and policy decision-makers who have to be constantly experimenting with new housing forms to alleviate Singapore's land scarcity.

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