Using Data and Algorithms to Reduce Public Housing Wait Times

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Shing-Yi Wang (UPenn) Maisy Wong (UPenn) Michael B. Wong (HKU)

Public housing waiting times have soared from an average of two years in 2010 to an average of 5.6 years in September 2023. Because of this, large numbers of low-income families reside in cramped and often substandard subdivided units. In response, the Government has launched the Transitional Housing and Light Public Housing programs. These initiatives aim to swiftly construct affordable housing options for those waiting for public rental housing.

However, there are concerns about the underutilization of Transitional Housing, especially in the New Territories, and the Government's ability to meet its target of eliminating subdivided units by 2049. These challenges call for a comprehensive and effective approach to tackle the housing crisis and improve the living conditions of the city's vulnerable populations in Hong Kong. In this paper, we propose using data analytics and computer algorithms to increase the utilization of Transitional Housing and reduce public housing wait times.

Problem: Low Utilization in the Transitional Housing Program

The Government introduced Transitional Housing (TH) and Light Public Housing (LPH) in 2018 and 2022 to provide short-term housing relief to vulnerable households, primarily on the public rental housing (PRH) waitlist and residing in subdivided units.[1] 8,420 and 5,540 TH units are expected to be completed in 2023 and 2024, respectively.[2] 30,000 LPH units are expected in the coming five years, with 2,100 in 2024-25. A large fraction of TH and LPH sites will be in relatively remote areas in the New Territories, such as Yuen Long and Sheung Shui.[3]

1 There are roughly 133,700 general applicants waiting for PRH at the end of 2022. There are about 107,000 sub-divided units in Hong Kong and there are about 214,000 people living in sub-divided units.

2 6960 TH units were completed in 2020-21.

3 For LPH, two announced sites are in Tuen Mun: one site is in Sheung Shui, and one site is in Yuen Long.

However, observers and analysts are increasingly concerned that TH and LPH sites in the New Territories will have low utilization. According to the government, the average occupancy of projects in the New Territories was close to 70 percent, versus over 90 percent for projects in urban areas or near public transport hubs. For example, United Court in Yuen Long had 800 vacant flats (out of 1,800 total) in November 2022, according to SCMP. Utilization may deteriorate since upcoming TH sites have even fewer transportation linkages than existing TH projects in the New Territories.

The vacancies are financially costly. Government financial assistance for each transitional housing unit is: (a) up to $200,000 per unit in vacant residential buildings, and (b) up to $550,000 per unit for erecting temporary structures on vacant land and in non-residential buildings[4]. Failure to move people out of subdivided housing results in higher rents and lower living standards for the urban poor. In this paper, we identify difficulties in the implementation of the TH program and propose improvements to policy design.

Why is Transitional Housing Utilization Low?

Reason 1: Spatial mismatch between residents and TH projects

Subdivided units are generally located in urban areas, where employment opportunities are abundant. Moving to the New Territories would require that households uproot themselves. The costs of moving include: (1) increased distance from employment opportunities;[5] (2) difficulties of children switching schools; (3) separation from existing social networks.

Reason 2: Inefficient application process

Following the TH model, LPH projects are operated, managed, and maintained by invited organizations. Each operator will allocate units according to criteria set by the Government, handle tenancy matters, implement exit plans for tenants, and provide social services based on the needs of tenants.[6] Applicants apply separately to different projects. Operators do not know which other projects an applicant has applied to, or their relative preferences. Applicants are free to reject unlimited offers and can wait to apply for better options. Each operator assigns TH units in a decentralized manner.

4 https://www.info.gov.hk/gia/general/201904/18/P2019041800364.htm?fontSize=1

5 In 2016, 42.2% of the low-income population who rented sub-divided flats worked in the same district where they lived. See: https://www.info.gov.hk/gia/general/201801/18/P2018011800590.htm?fontSize=1

6 See: https://www.legco.gov.hk/yr2022/english/panels/hg/papers/hg20221205cb1-847-1-e.pdf

To address these issues, the Government has recently started to provide moving cost subsidies and establish a centralized application portal. While these efforts are commendable, it is important to acknowledge that the current matching process is not optimized: applicants may choose to wait for better housing options, even when applicants prefer the units in the New Territories over their existing subdivided units. We believe that further adjustments are necessary to address underutilization.

Market Design: A Nobel-Winning Idea

To improve TH allocation and utilization, we turn to Alvin Roth's groundbreaking work in market design, which earned the Nobel Prize in Economics in 2012. The fundamental concept behind this work is to gather data about individuals' preferences regarding a given set of options, and then use computer algorithms to create matches that optimize overall utility. To illustrate, let's consider the case of TH applicants with varying preferences for different locations. These individuals would submit their preferences through a centralized portal, and the algorithm would then facilitate the matching process.

In recent years, computer algorithms have been successfully implemented to improve allocations across various domains. For instance, such algorithms have been used to match doctors with hospitals, students with schools, and kidneys to patients. An excellent example of this is the use of an optimized computer algorithm in New York City to assign students, which led to a significant improvement in the assignment process: from 31,000 unmatched students in 2003 prior to implementing the revised algorithm, to about 3,000 in 2004, according to the New York Times.[7] Since then, the algorithm has consistently assigned nearly half of all students to their first-choice schools. This is a testament to the effectiveness of computer algorithms in optimizing allocation processes and ensuring that individuals receive the best possible outcomes.

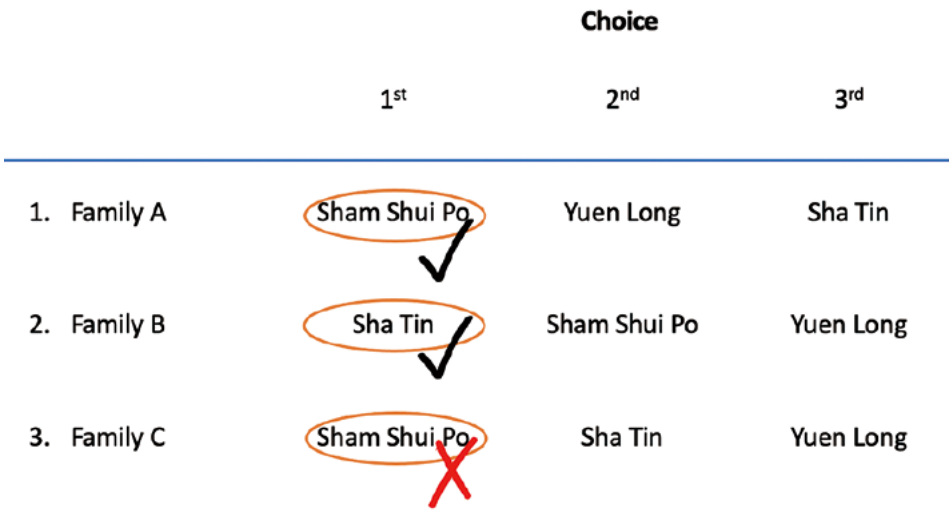
Illustrative Examples

Utilizing a centralized computer algorithm can significantly improve the allocation, utilization, and satisfaction of units when households have diverse preferences for housing options. To illustrate this, let us consider two simple examples where households have rank-order preferences for different locations.

7 See: https://www.nytimes.com/2014/12/07/nyregion/how-game-theory-helped-improve-new-york-city-high-school-application-process.html

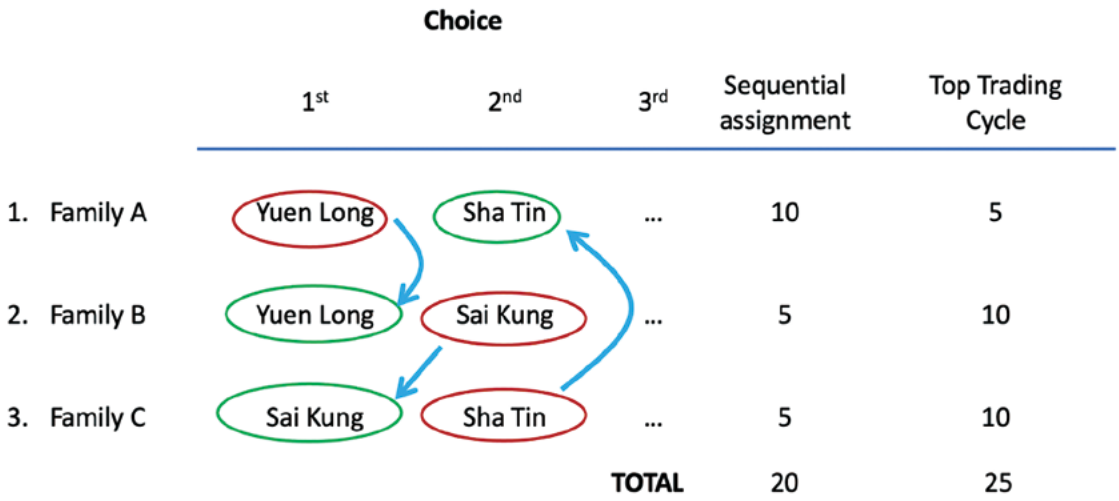
Figure 1 demonstrates the problems associated with decentralized assignment. In the current decentralized process, each household is limited to submitting one application at a time. However, if households prefer the same unit, vacancies can arise. For instance, suppose that a unit in Yuen Long is completed first, but no one applies for it, resulting in a vacant unit. Instead, as demonstrated in Figure 1, multiple families wait to apply for Sham Shui Po, only to discover later that it is oversubscribed. These inefficiencies can be resolved by eliciting household preferences and implementing an optimized algorithm that eliminates vacancies and oversubscriptions.

Figure 1: Vacancies Can Arise due to Decentralized Assignment



However, even with a centralized approach, using a basic algorithm may still yield suboptimal outcomes. Figure 2 shows an example. In this scenario, there is still only one available unit per location, and applicants are sequentially assigned to their top choice among the remaining units. The sequential algorithm assigns Family A to Yuen Long, Family B to Sai Kung and Family C to Sha Tin. However, this is an efficient algorithm because only one household gets its top choice. There exists a more effective algorithm called "Top Trading Cycles" (Shapley and Scarf 1974) that allows for better assignment of units based on households' preferences. In the example, if we assign Family C to Sai Kung, Family B to Yuen Long, and Family A to Sha Tin, two families get their top choice. Therefore, it is crucial to carefully study the properties of the assignment mechanism to ensure optimal results.

Figure 2: Optimized Algorithm Can Improve Satisfaction



Policy Recommendation

We recommend that the Housing Bureau leverage data analysis and market design theory to improve housing matches and increase TH utilization. In particular, we propose that:

1. Applicants submit preference rankings for TH projects to a centralized portal.

2. The central platform then uses an optimally designed computer algorithm, incorporating both applicants' preferences and operators' selection criteria and preferences, to allocate housing.

3. Applicants receive a limited number of housing unit offers to accept or reject, like in the PRH system.

4. Instead of a strict quota system reserving 80% of TH units to households with a ≥3-year wait in the PRH queue, such households are flexibly accounted for and prioritised in the assignment system, thereby minimizing vacancies.

These modifications can bring substantial benefits to TH applicants and residents. First, the proposed system's computer algorithm incorporates relative preferences, increasing the chances that applicants are matched with units they prefer.

Second, because the better matches are more aligned with applicants' needs, the proposed changes will increase offer acceptance rates. Meanwhile, limiting the number of offers to applicants will increase TH utilization in the New Territories by raising the incentives to accept an offer rather than waiting for an urban TH unit.

Implementation Requires Only Limited Investment

The proposed policy changes mentioned above would require only limited investment, making them a feasible solution. In particular, adding an assignment algorithm to the government's planned centralized application portal would require minimal software development.

Moreover, there is plenty of readily available expertise that can help design the centralized assignment algorithm. Local and international academic researchers have extensively studied the local context, making them a valuable resource in the implementation process.

A centralized system would not restrict operator autonomy, as operators can still retain the right to screen applicants post-centralized assignment to avoid unsuitable or potentially problematic tenants. In cases where applicants are rejected, they can re-enter the assignment algorithm to be reassigned to suitable housing options. This approach also reduces administrative overhead for operators since they will no longer have to handle overlapping applications.

Overall, the proposed policy changes offer a practical and cost-effective way to enhance TH allocation and utilization, ensuring that individuals are matched with suitable housing options while simultaneously reducing administrative costs and improving the efficiency of the allocation process.

Broader Benefits in the Housing System

While our initial proposal focuses on enhancing the Transitional Housing program, Hong Kong can leverage data analytics and computer algorithms to improve public housing provision on a broader scale. Scholars, such as Lui and Suen (2011) among others, have extensively documented significantly more spatial mismatch among residents of both Public Rental Housing and Homeownership Scheme homes compared to those in the private market. By collecting detailed preferences of housing location and characteristics and using computer algorithms to find optimal matches, we can substantially improve these allocations. These data can also be used to gauge the effectiveness of alternative housing policy interventions, such as allowing public renter households to swap units.

Using the methods we propose, policymakers can make data-driven allocations to achieve more efficient distribution throughout the public housing system. This approach aligns housing options with individual needs, thereby reducing spatial mismatch and generating significant welfare gains for a substantial population segment.

References

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