Portfolio

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Selected Works 2020 - 2024

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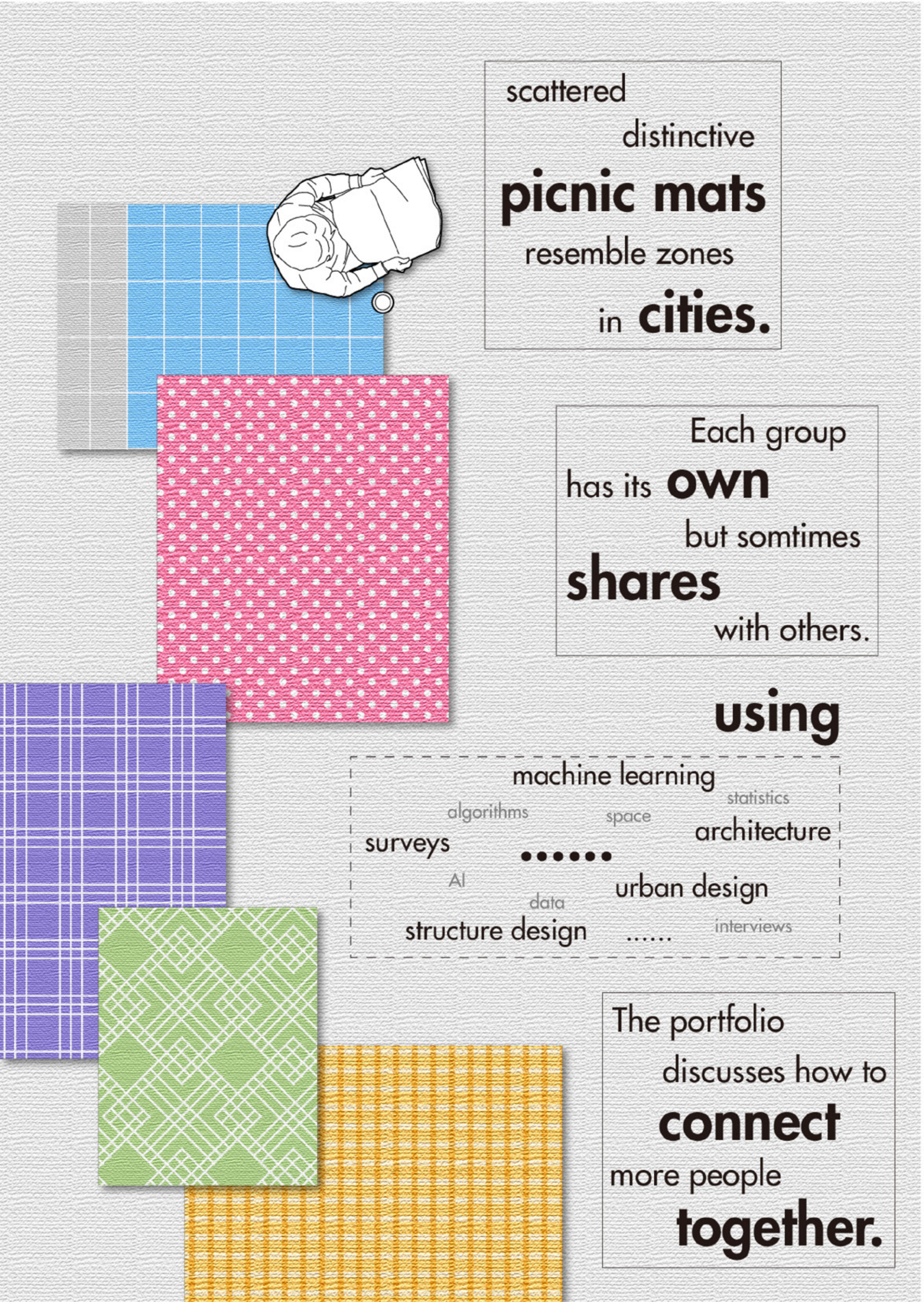
scattered
distinctive
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Each group
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but somtimes
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using
machine learning
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AI
urban design
data
structure design
......
interviews
The portfolio
discusses how to
connect
more people
together.

Contents

Revealing Urban Heat Island Effect
A Machine Learning Perspective

[Type] Research - Group work **[Publications]** *Urban Climate, eCAADe*

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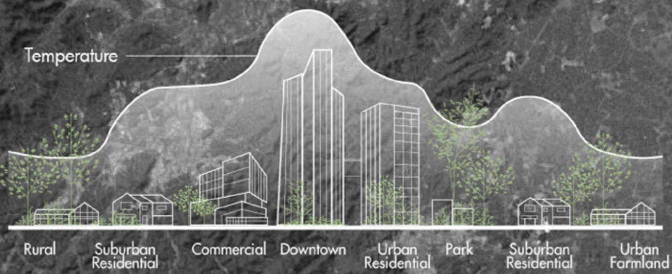
[Supervisor] Prof. Jiawei Yao - Tongji University

[Main Contribution] Data curation, Formal analysis, Software, and Visualization

[Time] 01/2023 – 09/2023

Introduction

Cities are currently facing overheating issues caused by global warming and the urban heat island (UHI) effect. These issues have numerous negative impacts on physical and mental health, energy consumption, and ecological environments. The planar and three-dimensional forms of urban elements, including buildings and green spaces, significantly influence the formation of urban heat islands. This project aims to develop a model, based on machine learning algorithms and explainable AI, to reveal the quantitative relationships between the morphological characteristics of buildings and greenery and the intensity of the urban heat island effect. Moreover, based on the predictive model and related findings established in this research, a monitoring and evaluation tool is envisioned for various stakeholders involved in urban development, aiming to help construct more ideal living environments.



Urban Heat Island Effect

An urban heat island occurs when a city experiences much warmer temperatures than nearby rural areas. The difference in temperature between urban and less-developed rural areas has to do with how well the surfaces in each environment absorb and hold heat. It is most apparent when winds are weak, under block conditions, noticeably during the summer and winter.

Energy Consumption

Human Health

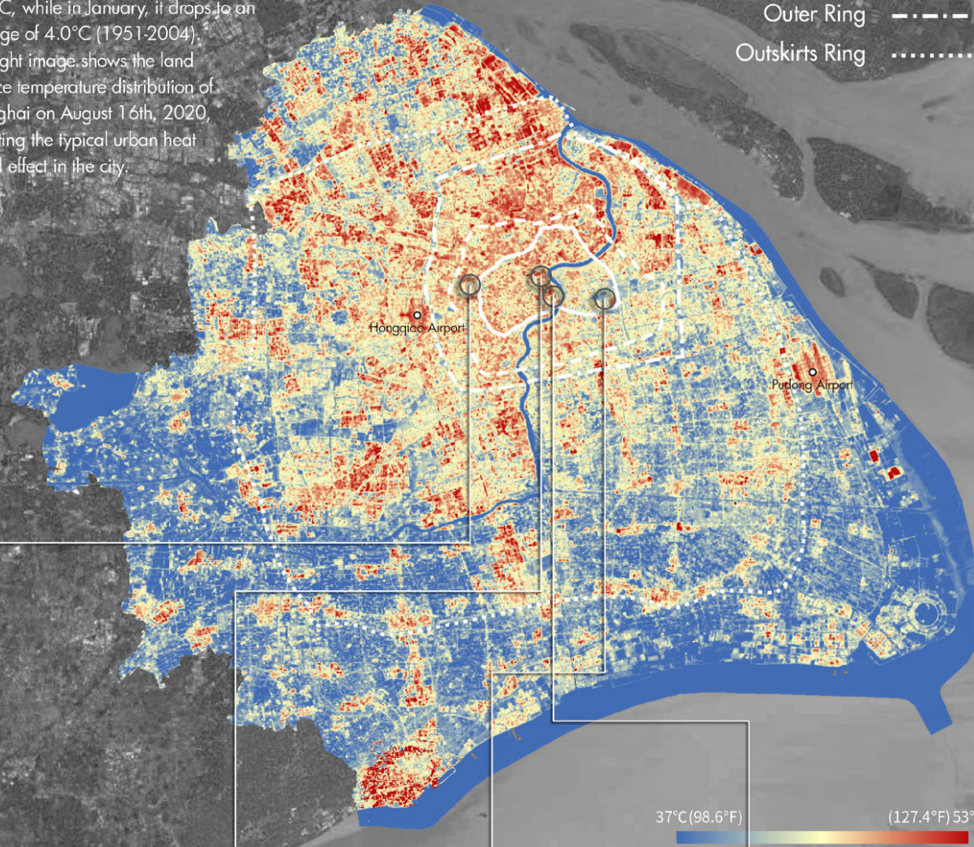
Ecosystem

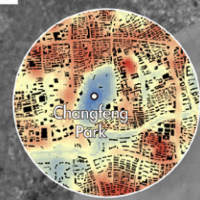
The Dangers of Urban Overheating

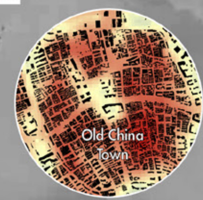
The dangers of urban overheating are multifaceted. Firstly, the more frequent use of air conditioners and other equipment significantly increases energy consumption. Secondly, high temperatures greatly elevate the risk of heatstroke and cardiovascular diseases in humans. Lastly, the overheated environment also poses a threat to urban wildlife, affecting their reproduction and survival.

Land Surface Temperature (LST) of Shanghai

Shanghai has a typical subtropical monsoon climate, with an annual average temperature of 17.0°C. In July, the average temperature reaches 27.7°C, while in January, it drops to an average of 4.0°C (1951-2004). The right image shows the land surface temperature distribution of Shanghai on August 16th, 2020, reflecting the typical urban heat island effect in the city.







The planar and stereo forms of urban elements, like buildings and green spaces, significantly influence the heat distribution. Quantifying these elements into measurable indicators for mathematical modeling will help us better understand the urban heat island effect.

Figure 1
Parks significantly cool the surrounding areas.

Figure 2
Buildings contribute to the accumulation of heat.

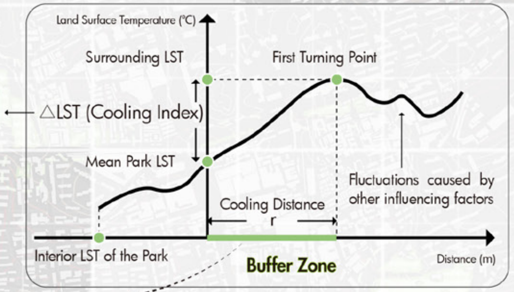
Figure 3
Different types of surfaces result in varying temperatures.

Figure 4
Different building height and density lead to varying temperatures.

Indicators for Modeling Green Spaces

CI

How to Calculate? Buffer Zone!



$$r = \sqrt{\frac{A_{green}}{\pi}}$$

The first turning point is usually difficult to identify, so we use a formula verified by many scholars to calculate the Cooling Distance (r) for each park.

Green spaces make a significant contribution to mitigating the urban heat island effect. However, their cooling effect has boundaries, which is defined as the buffer zone. The characteristics of the urban area within the buffer zone, along with the characteristics of the green space itself, will jointly influence its cooling capacity.

WP - TP - GP - LP - BP

The proportion of water/tree/ground/grass/building surface within the park

NDVI Normalized Difference Vegetation Index
(Reflect the growth and coverage of urban vegetation)

FAR

The Floor Area Ratio within the buffer zone

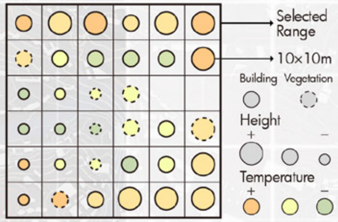
AREA

The area of the park

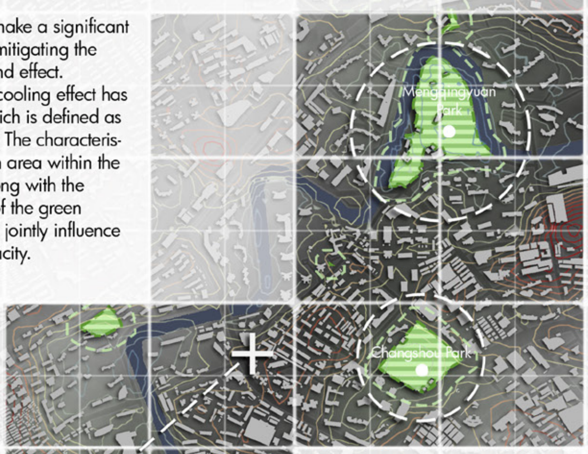
SI $SI = \frac{C_{green}}{2\sqrt{\pi * A_{green}}}$

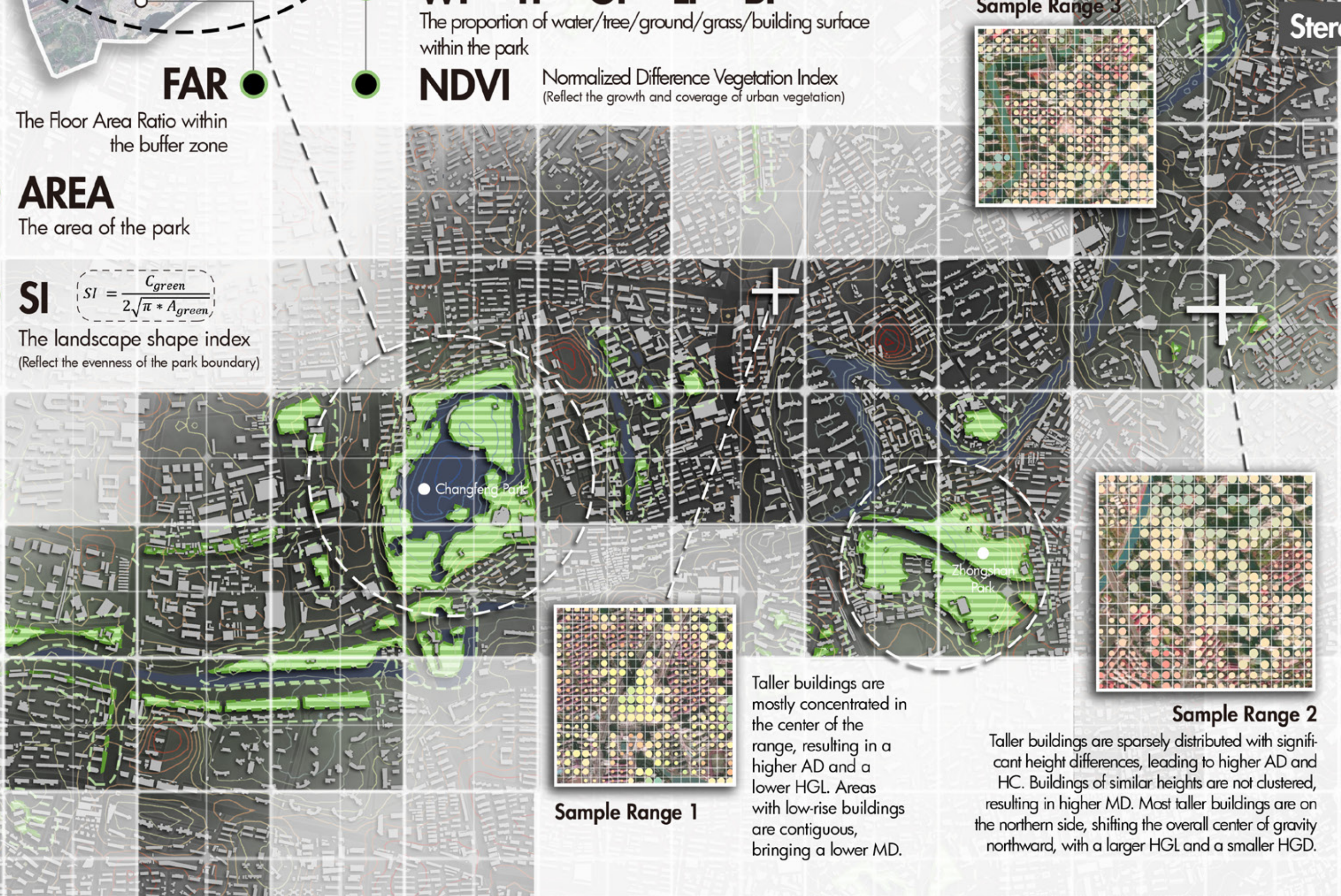
The landscape shape index
(Reflect the evenness of the park boundary)

Grids!



The stereoscopic structure of the city plays a crucial role in the formation of urban heat islands. We quantify this by dividing the city into a grid. The entire city is first divided into 10-meter square grids, and different numbers of grids are selected for analysis to calculate the stereoscopic indicators within the selected range.





Sample Range 1

Taller buildings are mostly concentrated in the center of the range, resulting in a higher AD and a lower HGL. Areas with low-rise buildings are contiguous, bringing a lower MD.

Sample Range 2

Taller buildings are sparsely distributed with significant height differences, leading to higher AD and HC. Buildings of similar heights are not clustered, resulting in higher MD. Most taller buildings are on the northern side, shifting the overall center of gravity northward, with a larger HGL and a smaller HGD.

Stereoscopic Indicators for Modeling Urban Spaces

HC **Height Variation Coefficient:**
Variation coefficient of heights within a grid.

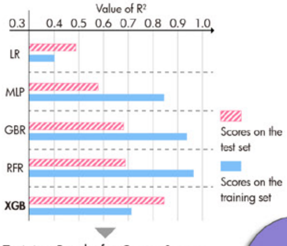
MD **Height Mixed Degree:**
Mixed degree of heights within a grid.

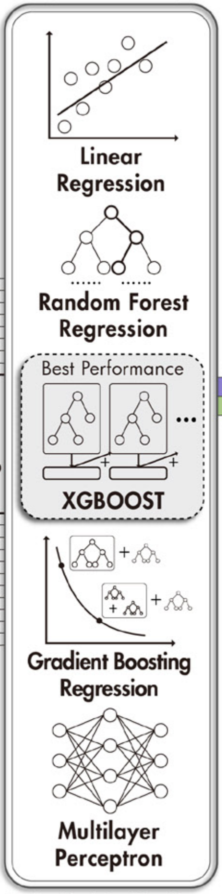
AD **Height Aggregation Degree:**
Aggregation degree of heights within a grid.

HGL **Height Gravity Length:**
Polar radius of the centroid of heights within a grid.

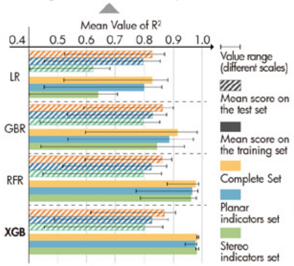
HGD **Height Gravity Direction:**
Polar angle of the centroid of heights within a grid.

Modeling and Analysis





Training Results for Urban Spaces



SHAP

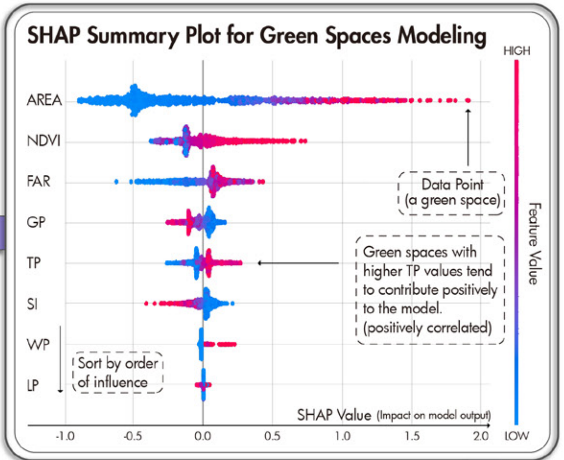
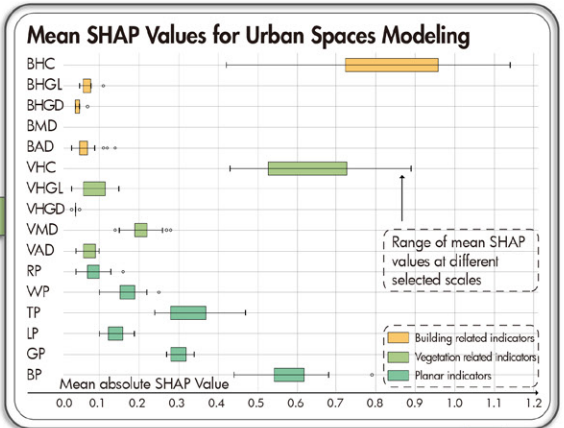


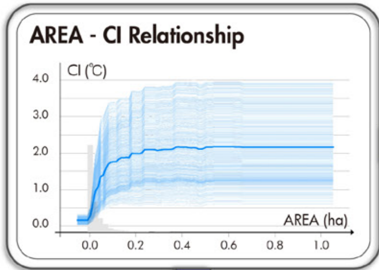
Figure above shows that AREA, NDVI and FAR are the most important features in the model. Larger AREA, NDVI and FAR enhance CI. Additionally, a larger GP reduces CI, whereas a higher TP increases CI. Simpler shapes of green spaces (SI) also improve cooling effects.

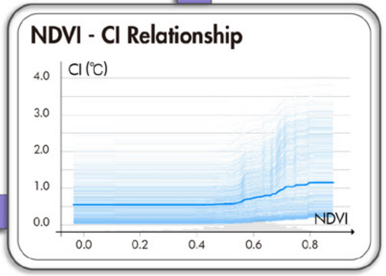
SHAP (SHapley Additive exPlanations) is an effective method for explaining the predictions of machine learning models, based on Shapley values from game theory. It is especially effective for explaining complex nonlinear models and providing intuitive visual explanations.



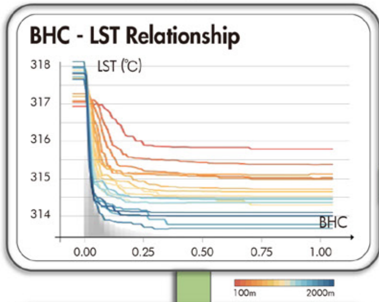
In 3D indicators, BHC and VHC have the highest contributions with average Shap values of 0.83 and 0.62 respectively. Lesser contributions are seen from indicators like VMD, BAD, and VAD. In 2D planar indicators, Built areas, Ground, and Trees show higher contributions to LST.

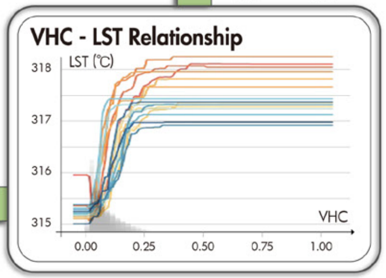
We used five-fold cross-validation to test all regression algorithms, finding that they performed well across grid sizes from 300m to 2000m. Additionally, Datasets with urban morphology indexes were more effective than those with only planar indicators. After considering multiple factors, we selected XGBOOST for our analysis.



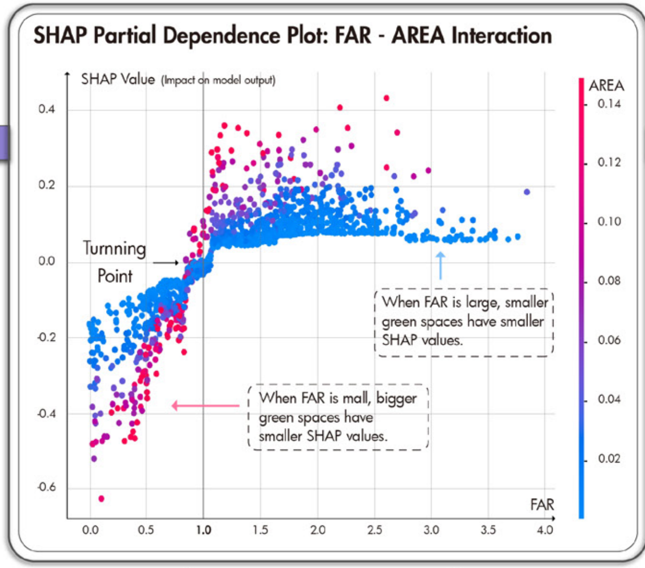


SHAP's Individual Conditional Expectation (ICE) plot: It shows how changes in a single feature, while keeping other features constant, affect model predictions.It helps reveal the specific impact of a particular feature on the outcome, enhancing the transparency of model decisions.



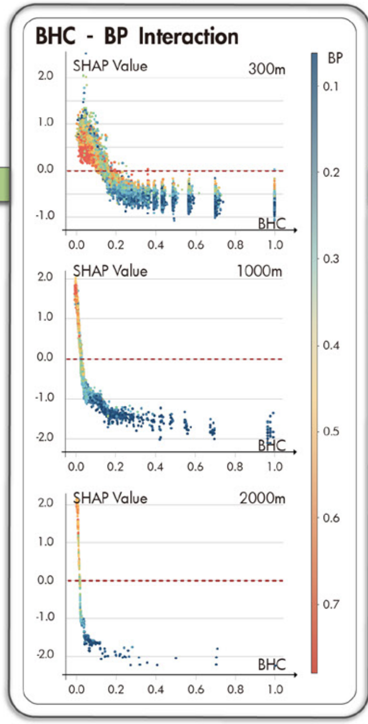


BHC has a negative nonlinear relationship with LST, while VHC have positive relationships. Additionally, as the sample size changes, the impact of each indicator varies. For instance, BHC's influence increases with a larger sampling radius, while VHC's influence decreases.



SHAP's Partial Dependence Plot (PD) Plot: the SHAP partial dependence plot can intuitively display the impact of a certain feature on the predicted value at different scales and incorporate the interaction between another feature.

Figure above illustrates the interaction between FAR and AREA. When FAR is constant, larger and smaller AREA values correspond to two different cooling patterns in green spaces. When the FAR is greater than 1, a larger green space area leads to a more significant cooling effect. The result suggests that establishing larger green spaces may be more effective in high-density urban areas.



The left figure displays three scales—300 m, 1000 m, and 2000 m—used in the Partial Dependence Plot (PDP) analysis to examine how BHC impacts LST and how BP interacts with BHC differently across these scales.

In areas with high BP, BHC consistently contributes positively to urban temperature. This suggests that in densely built urban centers, increasing the variation in building heights can lead to higher urban surface temperatures. Conversely, in areas with low BP, like suburbs or city parks, an increase in BHC potentially exhibits a cooling effect.

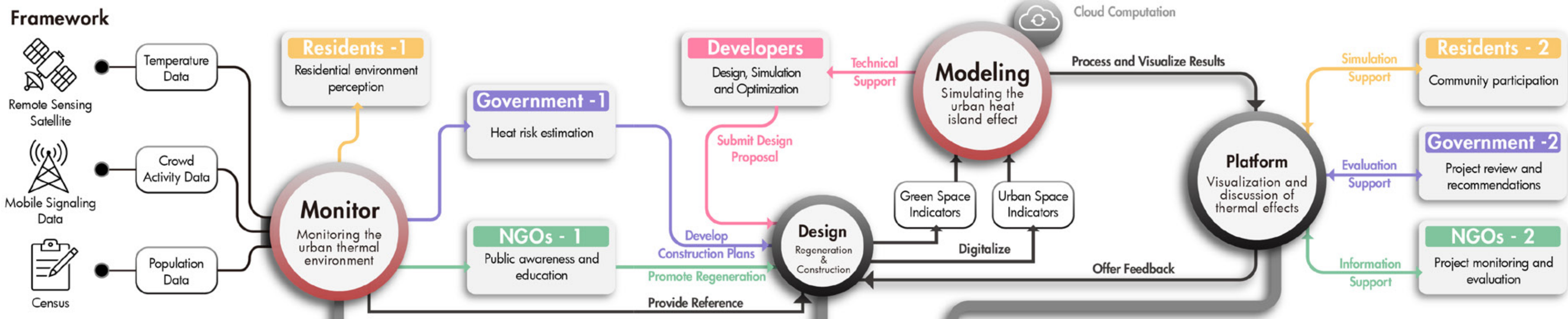
Complete conclusions can be found in the published papers ......

Urban Heat Monitoring and Design Evaluation Tool

Introduction

Based on the machine learning predictive model and related conclusions established in the research, a lightweight tool can be envisioned to provide heat effect monitoring and design evaluation throughout the entire process of urban planning and design, management, and regeneration. This tool can offer various types of support to the four main stakeholders: government, developers, residents, and NGOs, helping them collaboratively create a city with a better thermal environment.

Framework



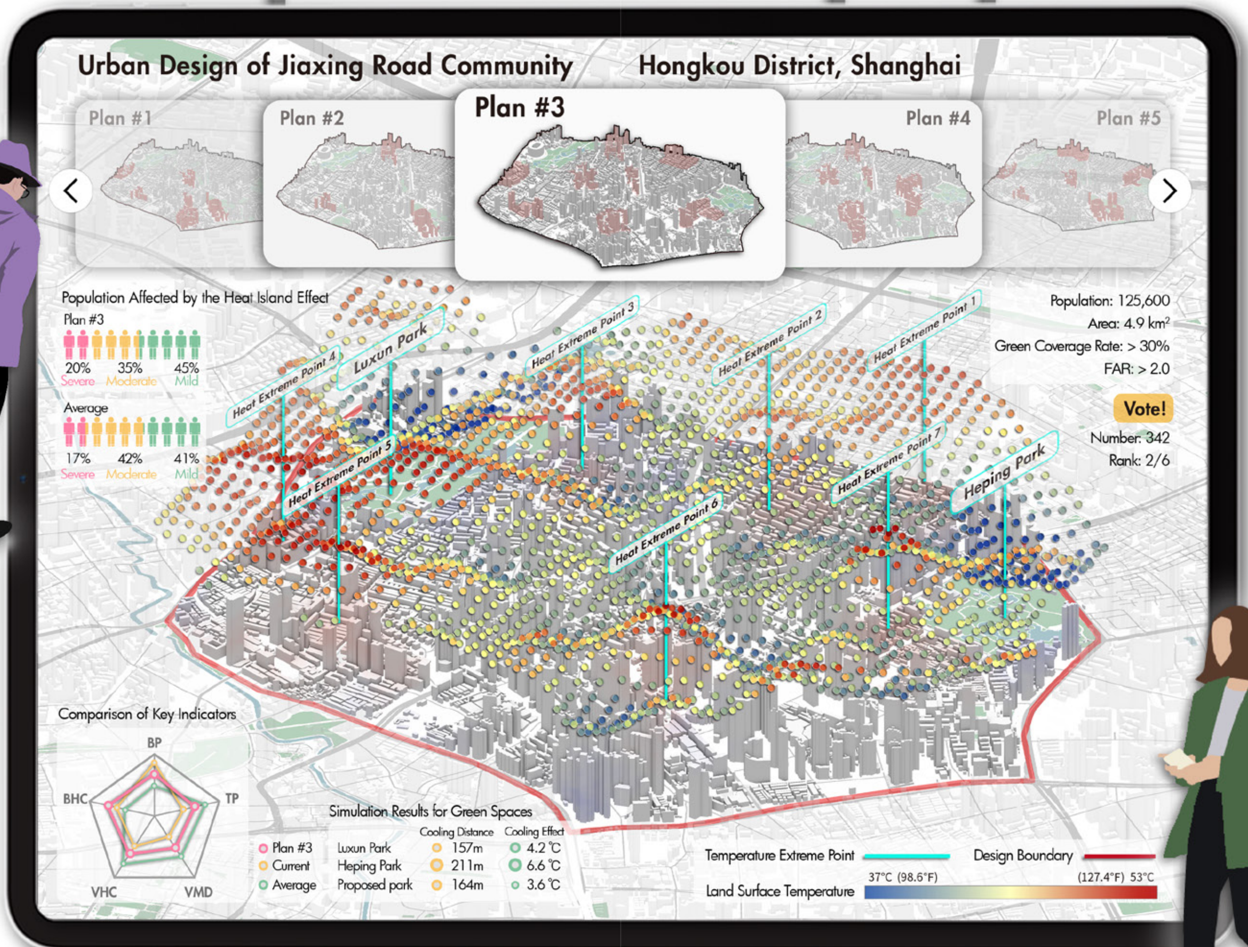
Government

1 Heat risk estimation

Combine crowd, population, and temperature data to identify areas with high heat risk and consider them for potential redevelopment and improvement.

2 Project review and recommendations

With the support of the urban heat island modeling platform, review design proposals and provide feedback and potential incentives to developers to minimize the heat island effect as much as possible.



Developers

1 Design optimization

Provide specific design recommendations, such as building density, height, and landscaping design, to minimize the heat island effect.

2 Real-time feedback and simulation

Use 3D visualization to show the thermal effects of different design proposals, helping designers achieve their design goals and obtain potential policy incentives.

Residents

1 Residential environment perception

Residents can better understand their living environment and respond proactively. This also provides useful references for residents when choosing a place to live.

2 Community participation

With the support of the urban heat island modeling platform, residents can quickly and intuitively understand the thermal benefits of design proposals and easily participate in design discussions.

NGOs

1 Public awareness and education

By visually observing the urban heat island effect, promote public awareness and involvement in mitigation measures.

2 Project monitoring and evaluation

With the support of the urban heat island modeling platform, monitor the implementation of urban planning projects and their actual impact on the urban thermal environment, actively participating in the design and practice process.

Mobility Justice: Rethink Scooter Bans
A Case Study in Shanghai

[Type] Research - Group work **[Publication]** *Transportation Research Part A/D (intended submission)*
[Authors] **Weikang Kong**, Xiaolan Huang, Fenghong An
[Supervisor] Prof. Mi Diao - Tongji University
[Main Contribution] Conceptualization, Data curation, Formal analysis, Methodology
[Time] 12/2023 – Present (Still in progress)

Introduction

Due to safety concerns, many cities in China have implemented bans on a new form of transportation—mobility scooters. However, these scooters have become an essential mode of transport for many elderly and disabled individuals, who often have few alternatives. This study focuses on the elderly population in Shanghai and aims to advocate for a reconsideration of the current policy. It explores the following three key questions:

1. Why do people choose to use mobility scooters?
2. How do people use mobility scooters, and what value do they provide to users?
3. What impacts could existing policies have on users?

By analyzing user characteristics, travel behavior, and the effects of current policies, this study aims to demonstrate the indispensable role of mobility scooters, and to propose more inclusive policies and planning strategies to remove barriers to mobility for the elderly population.

Why → **How** → **What**

Typical types of mobility scooters

Disability Mobility Scooter

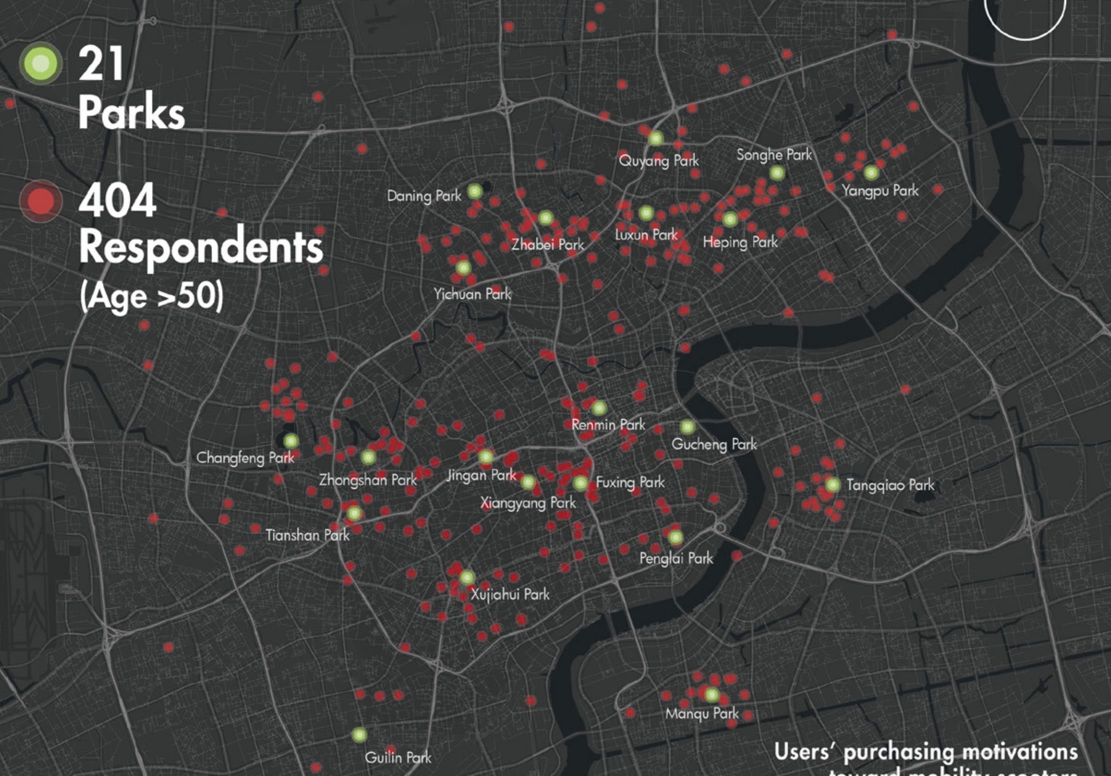
Senior Mobility Scooter
(type with fully enclosed shell)

Senior Mobility Scooter

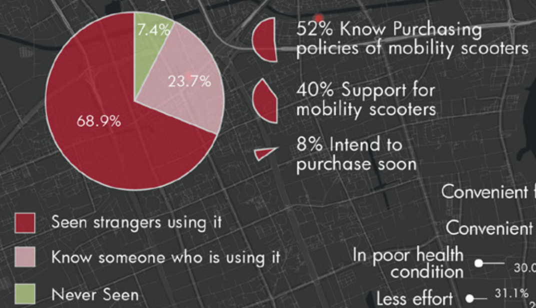
Mostly fuel-powered, these scooters have a top speed of 40-60 km/h. Only individuals with good upper body function but lower limb disabilities are eligible to apply for and drive them. In Shanghai, a permit and license plate are required, which can only be obtained with approval from the public security bureau. Despite these strict regulations, some physically healthy individuals manage to acquire and operate these scooters through unofficial or questionable means.

Senior mobility scooters are typically battery-powered, three-wheeled or four-wheeled vehicles, either fully enclosed or semi-enclosed. They don't meet the standards for either non-motorized or motor vehicles, placing them in a legal gray area. The ban mainly targets these vehicles. Senior mobility scooters do not require registration or licensing to purchase or use, and their quality can vary widely. Higher-end models usually feature a full enclosure and have a top speed of 40-60 km/h, while lower-priced models (shown on the right) typically have a top speed of around 20 km/h and may be open or only partially enclosed.

Study Site and People's Perceptions towards Scooters

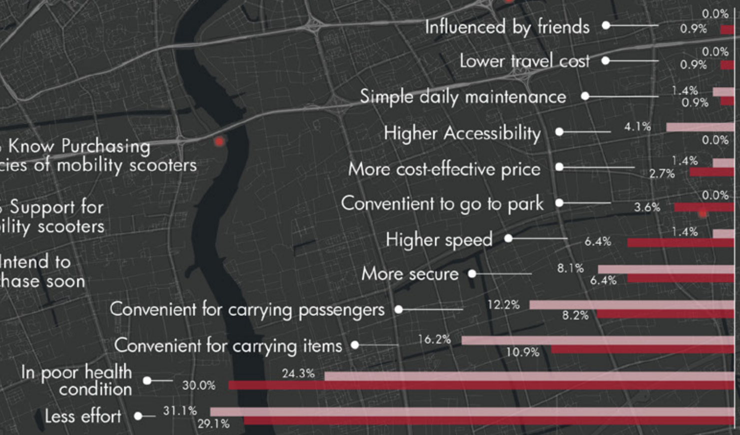


Non-users' perceptions toward mobility scooters



About 7.5% of respondents know little about mobility scooters, while most have seen others use them (68.9%) or know someone who does (23.7%). Around 40% support their use despite bans, while the rest are neutral or opposed. About 52% are familiar with the licensing and purchasing policies. Only 8% plan to buy one, while the rest have never considered it or don't need it.

Users' purchasing motivations toward mobility scooters

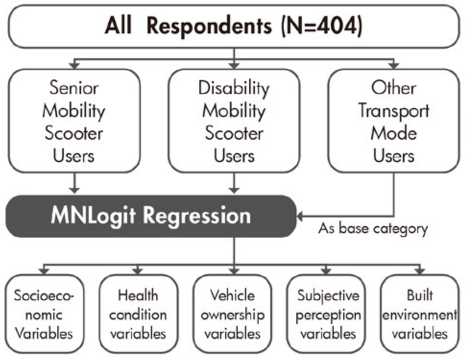


"Less Effort" is the main reason for choosing senior mobility scooters (31.1%) and the second for disability scooters (29.1%). Poor health is the second reason for senior scooters (24.3%) and the main reason for disability scooters (30.0%). These factors are significantly more common than others, highlighting health as a key influence. "Convenience for carrying items" (10.9% and 16.2%) and "carrying passengers" (8.2% and 12.2%) are also important, linked to the scooters' larger size and enclosed shell. Users also value "higher safety" (6.4% and 8.1%) due to better stability, and for disability scooter users, "higher speed" (6.4%) is a key factor. Senior mobility scooter users also prioritize "access to more places" (4.1%). Other factors like "low price" and "friend influence" were also mentioned.

Why Do Elderly People Choose Mobility Scooters

Multinomial Logit model

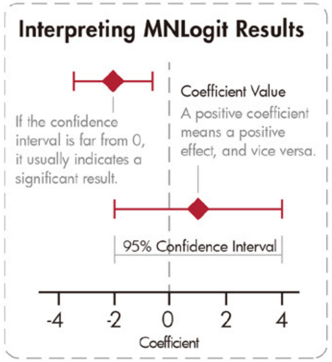
The Multinomial Logit regression model is a generalization of the binary Logit regression model to multiple categories and is commonly used in discrete choice modeling. It allows for a quantitative analysis of the factors influencing people's transportation mode choices. The model is built following the steps outlined below.



1. Divide the sample into three groups.

2. Perform the regression with "Other transport mode users" as the base category.
(This means that the results for the other two groups will be compared relative to the base category, highlighting their difference.)

3. Analyze the results based on variables from five dimensions.



Model Results Analysis

Socioeconomic Variables

In terms of socioeconomic factors, both "Gender" and "Monthly (gross) income level" are negatively correlated and significantly affect the choice of senior and disability mobility scooters. Men and individuals with lower incomes are more likely to choose these scooters. For disability mobility scooters, factors like lower education, having a driver's license, local household registration (hukou), and larger family size increase the likelihood of choosing this mode.

Health condition variables

In terms of health condition variables, the "Severe Mobility-Impacting Condition" indicator shows strong significance with a positive correlation. This suggests that individuals whose mobility is severely affected by disabilities, surgery, or other factors are more likely to choose senior or disability mobility scooters.

Vehicle ownership variables

Considering vehicle ownership variables, the ownership of bicycles is negatively correlated and significant for both types of mobility scooters. For senior mobility scooters, higher ownership of cars and E-bicycles significantly reduces the likelihood of choosing this mode.

Subjective perception variables

Regarding subjective perception variables, users' negative perceptions of the metro system significantly influence their choice of either type of mobility scooter, increasing the likelihood of selecting these modes.

Built environment variables

For built environment variables, if there is a charging station within the residential area, the likelihood of choosing a senior mobility scooter significantly increases, with higher population density in the area also boosting this likelihood. For disability mobility scooters, unexpectedly, proximity to a subway station significantly increases the likelihood of choosing this mode.

Table1. Multinomial Logit model for predicting probability of senior and disability mobility scooter mode choice

Variables	Senior Mobility Scooter (N = 26) p - value	Disability Mobility Scooter (N = 43) p - value
Socioeconomic Variables		
Gender (Male =0, Female =1)	0.007 ***	0.001 ***
Age group	0.646	0.156
Education level	0.213	0.045 **
Retirement	0.679	0.459
Monthly (gross) income level	0.003 ***	0.008 ***
Driving license ownership (No = 0, Yes = 1)	0.704	0.004 ***
Registered residence (Non-local = 0, Local = 1)	0.182	0.024 **
Household size	0.736	0.000 ***
Child Pickup and Drop-off (No = 0, Yes = 1)	0.201	0.391
Health condition variables		
Severe Mobility-Impacting Condition	0.000 ***	0.000 ***
Moderate Mobility-Impacting Condition	0.834	0.602
Mildly Mobility-Impacting Condition	0.966	0.575
Vehicle ownership variables		
Private car ownership	0.127	0.067 *
Private bicycle ownership	0.024 **	0.098 *
E-bicycle ownership	0.609	0.026 **
Subjective perception variables		
Negative attitude towards bus service (No = 0, Yes = 1)	0.255	0.414
Negative attitude towards metro service (No = 0, Yes = 1)	0.000 ***	0.000 ***
Built environment variables		
EV charging station in the residential community	0.023 **	0.441
Population density	0.066 *	0.381
Road density	0.131	0.271
Land use mix	0.674	0.874
Access to bus stops	0.991	0.893
Distances to the nearest metro station	0.604	0.058 *
Distances to the nearest park or green spaces	0.992	0.623
Distances to the nearest market	0.567	0.641
Distances to the nearest convenience store	0.482	0.330

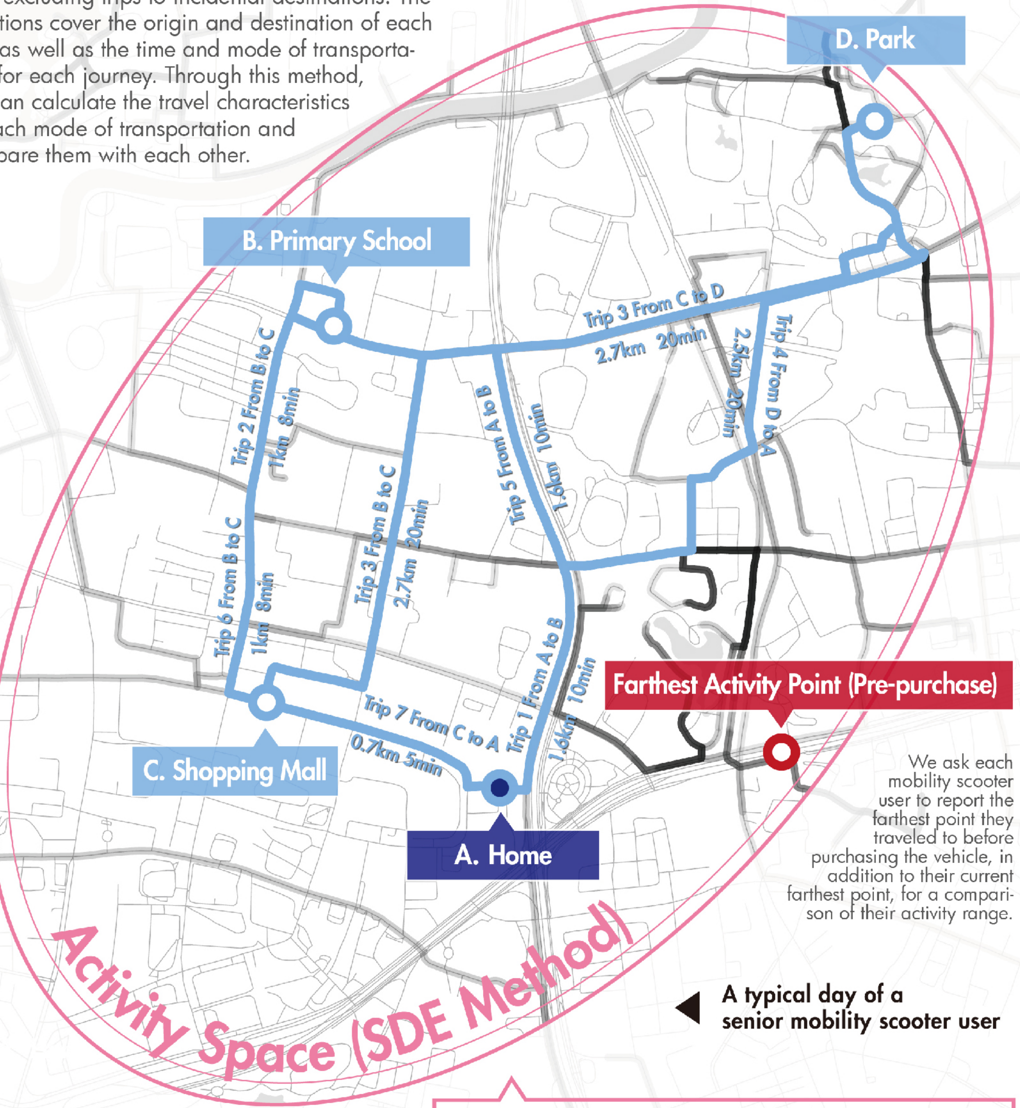
Log-Likelihood: -114.75 Pseudo R^2: 0.500

Note: * Statistically significant at the 10% level (i.e., $p < 0.10$), ** Statistically significant at the 5% level (i.e., $p < 0.05$), *** Statistically significant at the 1% level (i.e., $p < 0.01$). Statistically significant variables are highlighted in darker colors.

How Do Elderly People Use Mobility Scooters

Typical Day Travel Diary Method

Respondents are asked to list all trips in their typical day, excluding trips to incidental destinations. The questions cover the origin and destination of each trip, as well as the time and mode of transportation for each journey. Through this method, we can calculate the travel characteristics of each mode of transportation and compare them with each other.



We ask each mobility scooter user to report the farthest point they traveled to before purchasing the vehicle, in addition to their current farthest point, for a comparison of their activity range.

A typical day of a senior mobility scooter user

Farthest Activity Point (Post-purchase)

We ask each respondent to report a frequently visited destination they consider the farthest from home, to improve the accuracy of the Activity Space calculation.

Measurement of Activity Space

Activity space is a concept used to more accurately capture an individual's exposure to different environments. Its calculation can be used to effectively assess the accessibility of different modes of transportation within urban space. The standard deviation ellipse (SDE) is a common evaluation method, which is calculated by covering a certain percentage of all the origin and destination points of an individual's travel activities.

Mobility Scooter Users' Travel Characteristics

A series of regression models are calibrated to compare mobility characteristics of older people across different modes of transport while controlling for other factors.Five mobility characteristics are used as dependent variables. For trip-level dependent variables, including trip time, trip distance, and trip speed, we adopt Multilevel Linear Models (MLM) with random intercepts at the individual level to account for the potential clustering effects among trips made by the same individual. For individual-level dependent variables, namely the number of trips and activity space, we apply Ordinary Least Squares (OLS) regression models. The MLM can be specified as:

$$Y_{ij} = \beta_0 + \beta_1 \cdot Walking_{ij} + \beta_2 \cdot Bicycle_{ij} + \beta_3 \cdot EBike_{ij} + \beta_4 \cdot DisabilityScooter_{ij} + \beta_5 \cdot Bus_{ij} + \sum_{i}^{K} \gamma_i \cdot C_{ij} + u_{0j} + \epsilon_i$$

Table 2. Results of the MLM and OLS regression models

	Trip time (min)	Trip distance (km)	Trip speed (km/h)	Number of trips	Activity space (km²)
	Coef. (S.E.)	Coef. (S.E.)	Coef. (S.E.)	Coef. (S.E.)	Coef. (S.E.)
Intercept	**19.818 (5.516) *****	**4.182 (1.026) *****	**10.620 (1.892) *****	**2.735 (0.588) *****	**15.746 (10.742)**
Transportation mode					
Walking	**1.456 (2.224)**	**-0.315 (0.382)**	**-3.317 (0.744) *****	**-0.353 (0.240)**	**-5.823 (4.472)**
Bicycle	**7.268 (2.532) *****	**0.715 (0.431) ***	**-0.529 (0.902)**	**-0.437 (0.313)**	**-0.24 (5.706)**
E-bike	**-0.747 (2.418)**	**-0.479 (0.417)**	**-0.901 (0.836)**	**0.000 (0.273)**	**0.645 (5.058)**
Disability mobility scooter	**-1.539 (2.566)**	**0.135 (0.473)**	**1.938 (0.877) ****	**-0.563 (0.275) ****	**13.053 (5.095) ****
Bus	**10.931 (2.350) *****	**2.147 (0.403) *****	**1.879 (0.819) ****	**-0.230 (0.286)**	**13.288 (5.299) ****
Socioeconomic variables					
Gender (Male = 0, Female = 1)	2.052 (1.150) *	-0.092 (0.218)	-0.605 (0.399)	-0.046 (0.124)	0.124 (2.276)
Age group	-0.240 (0.353)	-0.061 (0.067)	0.001 (0.122)	0.046 (0.038)	0.108 (0.683)
Education level	0.261 (0.543)	0.027 (0.102)	0.160 (0.186)	-0.059 (0.058)	-0.21 (1.062)
Retirement	-4.471 (2.411) *	-0.655 (0.456)	-0.133 (0.838)	0.060 (0.259)	5.471 (4.74)
Monthly (gross) income level	-0.952 (0.482) **	-0.204 (0.092) **	-0.009 (0.167)	0.035 (0.052)	0.285 (0.94)
Driving license ownership (No = 0, Yes = 1)	0.439 (1.173)	0.024 (0.222)	0.109 (0.405)	0.008 (0.126)	-0.985 (2.324)
Registered local residence (No = 0, Yes = 1)	3.065 (1.532) **	0.622 (0.290) **	0.564 (0.531)	0.069 (0.167)	-1.512 (3.025)
Household size	-0.838 (0.519)	-0.135 (0.099)	-0.228 (0.179)	0.042 (0.056)	-0.272 (1.027)
Child Pickup and Drop-off (No = 0, Yes = 1)	1.906 (1.393)	0.271 (0.263)	-0.345 (0.480)	0.626 (0.152) ***	-0.973 (2.761)
Health condition					
Severe Mobility Impairment	3.636 (2.232)	0.240 (0.419)	-0.916 (0.761)	-0.185 (0.238)	6.433 (4.308)
Moderate Mobility Impairment	-4.102 (1.070) ***	-0.593 (0.202) ***	-0.576 (0.369)	-0.012 (0.114)	-3.566 (2.075) *
Mild Mobility Impairment	2.817 (1.214) **	0.013 (0.230)	-1.557 (0.418) ***	0.230 (0.130) *	-1.163 (2.379)
Built environment variables					
Charging station	1.205 (1.076)	0.099 (0.204)	-0.321 (0.373)	0.114 (0.115)	-1.336 (2.134)
Population density	-0.161 (0.053) ***	-0.029 (0.010) ***	0.007 (0.018)	-0.004 (0.006)	-0.349 (0.103) ***
Road density	-0.215 (0.191)	-0.033 (0.036)	-0.101 (0.066)	0.001 (0.020)	0.587 (0.381)
Land use mix	-0.402 (3.972)	-1.658 (0.746) **	-2.867 (1.349) **	0.087 (0.415)	-20.437 (7.801) ***
Access to bus stops	0.236 (0.182)	0.013 (0.035)	-0.000 (0.063)	-0.004 (0.019)	-0.02 (0.357)
Distances to the nearest metro station	0.090 (1.516)	-0.208 (0.287)	-0.382 (0.524)	0.043 (0.162)	1.363 (2.965)
Distances to the nearest park or green spaces	7.649 (1.686) ***	1.459 (0.319) ***	0.902 (0.584)	-0.246 (0.182)	8.254 (3.321) **
Distances to the nearest market	4.796 (4.018)	1.699 (0.760) **	2.355 (1.403) *	-0.422 (0.429)	-5.628 (7.879)
Distances to the nearest convenience store	1.759 (4.686)	0.618 (0.891)	0.448 (1.635)	0.485 (0.501)	2.855 (9.229)
R-squared	0.477	0.509	0.507	0.126	0.252

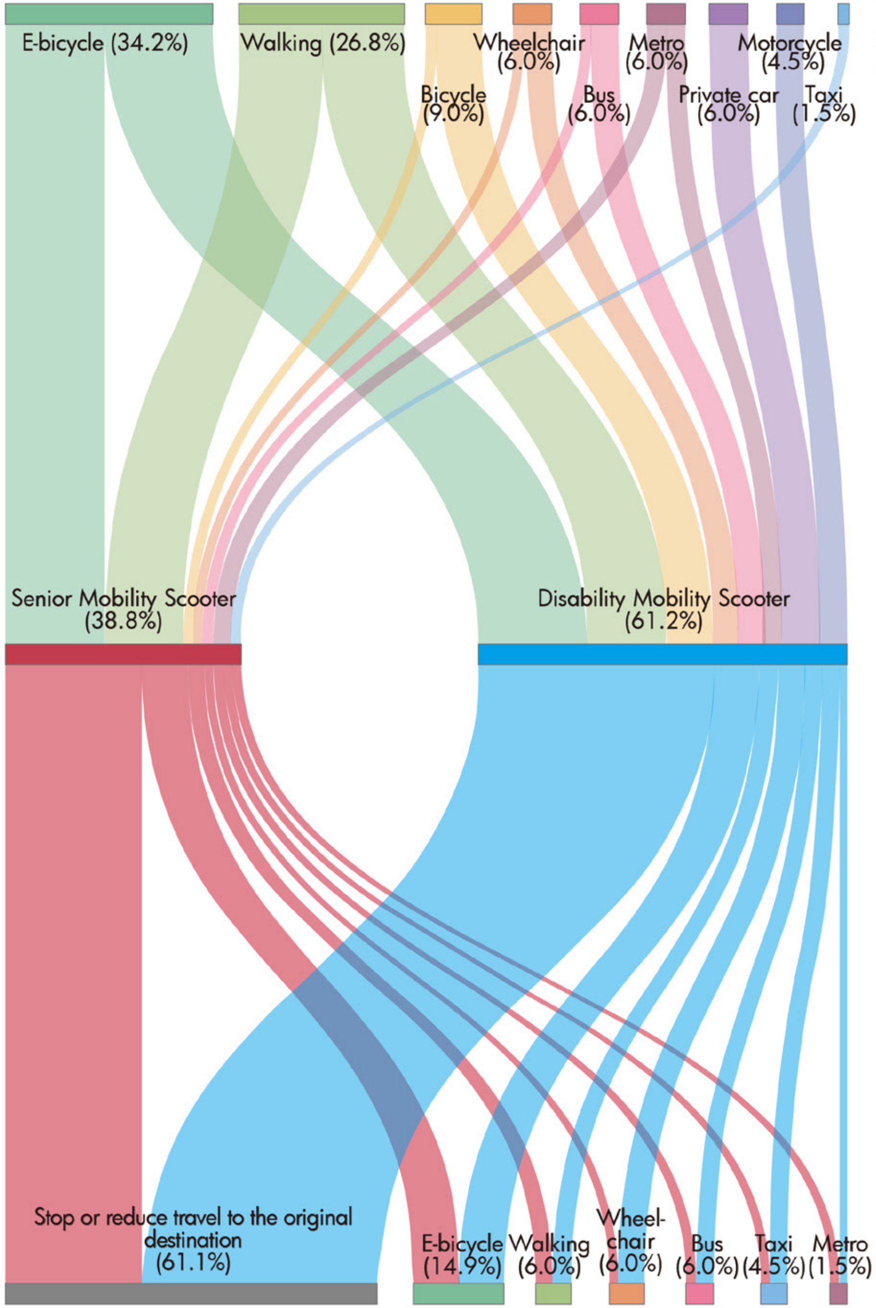
Note:*, **, ** denote statistically significant at the 0.10, 0.05, and 0.01 levels, respectively

The analysis shows that senior mobility scooter users have an average travel time of about 20 minutes and travel roughly 4.18 kilometers per trip at a speed of 10.6 km/h. Their travel time is significantly shorter than that of bicycle and bus users, while their travel distances are comparable to those of pedestrians, cyclists, and e-bike users but much shorter than bus trips. In terms of speed, senior mobility scooters are notably faster than walking but similar to bicycles and e-bikes. Senior users make about 2.7 trips per day, a rate close to that of e-bike users, while disability mobility scooter users travel less frequently, likely due to health limitations. Regarding spatial range, senior mobility scooter users cover an average activity space of about 15.75 km², larger than that of pedestrians but smaller than that of disability mobility scooter and bus users, indicating that mobility scooters play an important role in extending the daily mobility and accessibility of seniors.

What Impacts Could Bans Have on Elderly People

Mode shift of mobility scooter users

In the interviews, we asked mobility scooter users about their main mode of transportation before purchasing the scooter and what alternative they would use if they couldn't use it. This helped assess the impact of strict transportation policies, especially on senior mobility scooter users. The Sankey diagram below shows the mode shifts, with line thickness representing the shift percentage and colors indicating different transport modes.



Before Purchasing

Around 73.2% of mobility scooter users relied on vehicles before purchasing the scooter, with 34.2% using E-bikes and 9.0% using bicycles. This suggests a trend toward upgrading to more stable, faster transport. Some users also relied on cars, taxis, motorcycles, electric wheelchairs, or public transport. Senior mobility scooter users, however, were less likely to have used motorized transport.

Current Mode

When asked about alternatives if they couldn't use their mobility scooter, 61.1% of users said they would stop or reduce trips, highlighting the scooter's importance. The next most common option was switching to an E-bike (14.9%). Only 6.0% would return to walking, a sharp decline from before they got the scooter, indicating that walking is less convenient compared to using a mobility scooter.

Alternative Choice

Discussions and Policy Suggestions

Reasons why mobility scooters are chosen as the primary mode of transport for elderly people

1 Health issues: the driving force

Health condition is a key factor in choosing mobility scooters. Our analysis shows that users often cite "less effort" and "poor health" as main reasons for choosing these vehicles. Many users who previously walked also indicated they would reduce or stop traveling if scooters were unavailable. The MN Logit model confirms that severe mobility limitations strongly influence scooter choice.

For individuals with severe mobility impairments, such as lower limb disabilities, traditional transportation or walking is not feasible. Mobility scooters provide a stable and easy-to-use solution. For elderly people with conditions like arthritis or heart disease, scooters reduce fatigue and improve travel efficiency, offering a better alternative to two-wheeled vehicles like bicycles or e-bikes.

2 Socioeconomic characteristics

Income, education, gender, and social roles all influence mobility scooter use. Men are the primary users, likely due to gendered driving norms and a desire for independence, while larger households also increase scooter use, with women and children more often riding as passengers.

Lower-income and less-educated individuals are more likely to use scooters, despite their higher cost compared to bicycles or e-bikes. This may due to their poorer health and limited transport options. This may also indicates that the role of mobility scooters is not purely "improvement-oriented," as commonly believed, but rather an essential option for individuals facing mobility constraints.

3 Built environment characteristics and vehicle ownership

The choice of mobility scooters among the elderly is influenced by factors like public transport accessibility, vehicle ownership, and the availability of charging stations. Interestingly, living closer to subway stations correlates negatively with scooter use, likely due to poor accessibility facilities. Charging stations in residential areas increase scooter use, highlighting the importance of infrastructure.

Ownership of cars, bicycles, and e-bikes negatively impacts the use of disability scooters. When unavailable, fewer users revert to other transport options, this all suggesting that the emergence of mobility scooters fills a specific niche in the transportation landscape. This choice is not merely a preference but a natural, even inevitable, outcome given the current transportation conditions and social context.

Travel behavior of mobility scooters and their values

Overall, scooters reduce travel costs for the elderly and maintain their activity space despite mobility limitations. Mobility scooters perform well in speed and travel time, often rivaling buses for short to medium distances. They help the elderly overcome physical barriers, offering convenience and time savings.

Activity space analysis shows that scooter users' activity space is comparable to that of other transport users, especially for disabled users. Scooters enable elderly individuals to reach farther destinations, enhancing their social participation and reducing isolation. While scooter use may reduce walking time, reducing opportunities for physical exercise, it significantly improves the quality of life for older adults.

The potential impact of the restrictive policy on mobility scooters and policy suggestions

When we asked respondents about alternative transportation options if mobility scooters were unavailable, 61.1% of users said they would reduce or stop traveling altogether. This highlights the crucial role mobility scooters play in the lives of many elderly and disabled individuals, and the potential negative impact of restrictions on their physical and mental health, including a decline in health and increased risk of depression.

As previously discussed, mobility scooters are often the only viable option for elderly people with limited mobility, especially in cities with inadequate accessible public transport. A more inclusive urban transportation system should focus not only on meeting residents' travel needs but also their need for travel choices. We believe that the popularity of mobility scooters is temporary, emerging to fill a gap in the transportation ecosystem. As this gap gradually gets filled, mobility scooters may eventually be phased out. The most effective way to control their numbers may be to improve the availability of public transportation and broaden citizen's transport selection, thereby expanding residents' travel options more broadly.

New Water Town: “Tuan” Reunited
Urban Design of Chuansha Sub-center

[Type] Urban Design - Group work

[Course] Urban Design **[Time]** 03/2024 – 06/2024

[Author] Weikang Kong, Jingyi Gao **[Contribution]** Tram leader, Conceptualization, Urban Design

[Supervisor] Prof. Xiaoming Kuang - Tongji University
Prof. Jianli Xiao - Tongji University

Introduction

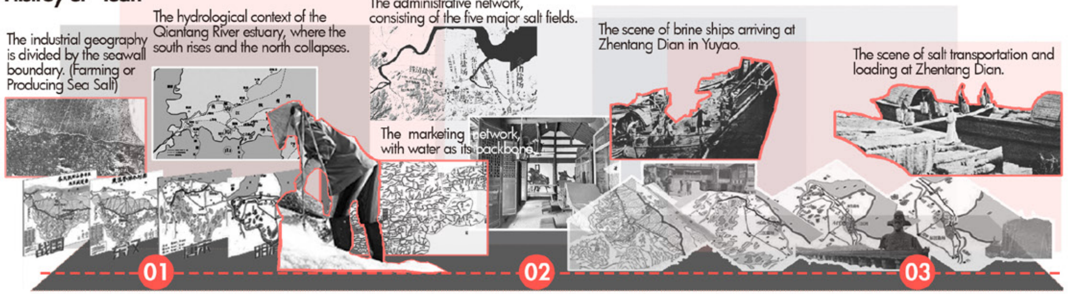
The ChuanSha Urban Sub-center is a new city being developed from the ground up in Shanghai, which is located in the southeastern corner of Shanghai's main urban area, adjacent to the Disney Resort. In the plan, It mainly serves functions such as tourism and leisure, innovation and technology office spaces. The urban design draws inspiration from the historical "Salt Tuan" community structure along Shanghai's coastal region, aiming to reimagine this traditional social organization and urban framework in a modern way. It seeks to reconnect today's isolated urban lives and contribute to the development of an innovative city for the future.

SITE

Shanghai Pudong District Chuansha Town

"Tuan" as an Urban Organization Model

Histroy of "Tuan"



01 Boiling the Sea to **Create Land**

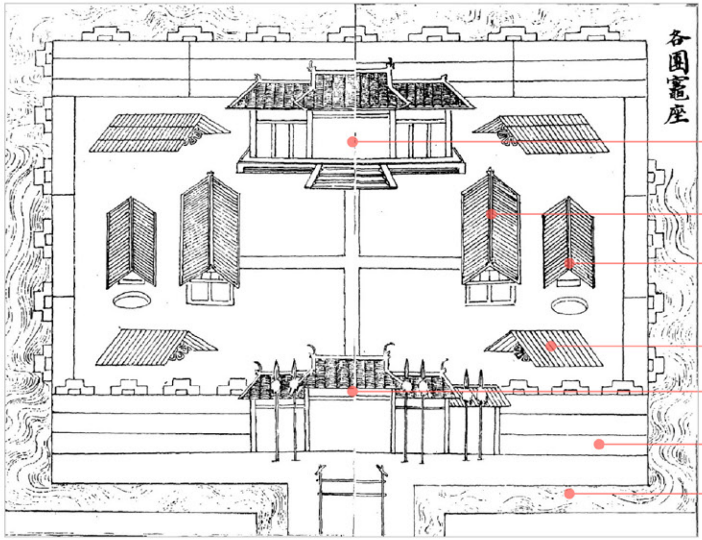
The historical outcome of the intense hydrological movements at the Qiantang River estuary, governed by the natural law of the south rising and the north collapsing, has continuously pushed the coastline northward.

02 Boiling the Sea to **Form Connections**

In the geography dominated by the salt industry, this region naturally developed a social structure distinct from that of agricultural areas. A unique production, transportation, and sales network system was established across various dimensions, including production, commerce, administration, and transportation.

03 Boiling the Sea to **Foster Communities**

In this salt-dominated society, the coastal areas also gave rise to a series of towns and villages that developed around salt as the primary driving force. Due to the scarcity of salt, the government established "Tuan" to strictly control this process.



Spatial Feature of "Tuan"

◀ Aobotu (Illustrated boiling of sea water)
Yuan period, Chen Chun (1293-1335)

The diagram illustrates the abstract structural relationship of the "Tuan" layout.

Administrative Building
The government stations officials here to manage salt production, storage, transportation, and security tasks.

Residential Building
Residential buildings represent all the houses where a work unit lives.

Production Building
Production buildings are managed by a work unit and include equipments such as stoves outside.

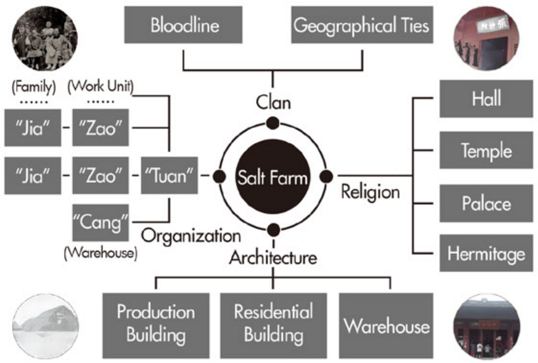
Warehouse
Storage warehouses are used to store the processed sea salt or production equipment.

Main Gate
Gates are used for controlling access, with soldiers strictly overseeing the entrance to prevent theft or illegal trading.

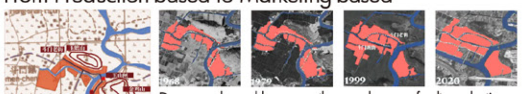
High Wall
The walls serve a protective function, preventing outsiders from entering easily.

Moat
Together with the walls, they work to protect the "Tuan."

Feature 1 Strong social cohesion
Production Spaces Create a Unique World



Feature 2 Diverse Functions
From Production-based to Marketing-based

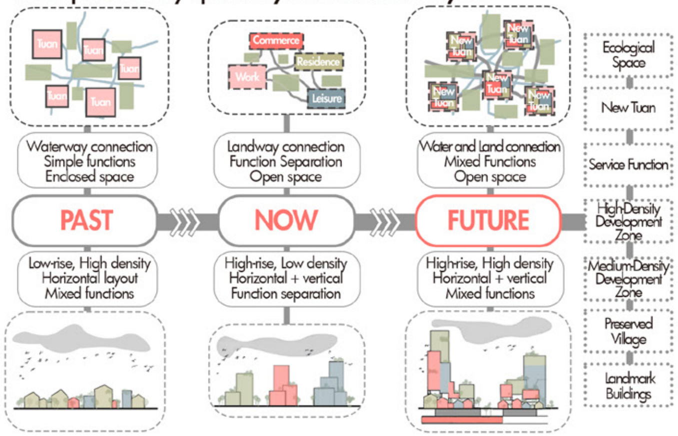


Doumen, shaped by over a thousand years of salt production, became a large town by the Republic era. Built between mountains and water, it grew along the main postal road, with markets, salt farms, docks, and warehouses.

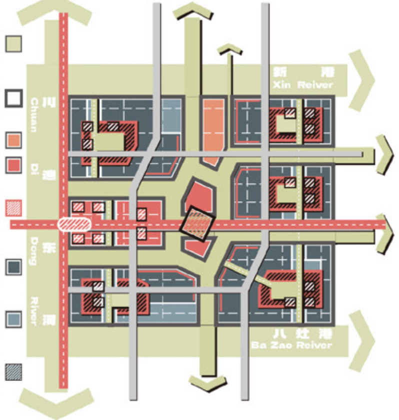
Feature 3 Rich Communication
Salt Industry Connecting Regions

The prosperity of the salt industry spurred related industries, linking the entire region. In Yugang Village, many people made bamboo and wicker products. Yu Xiangzhou founded the Shaoxing Steamship Company, pioneering steamship transport.

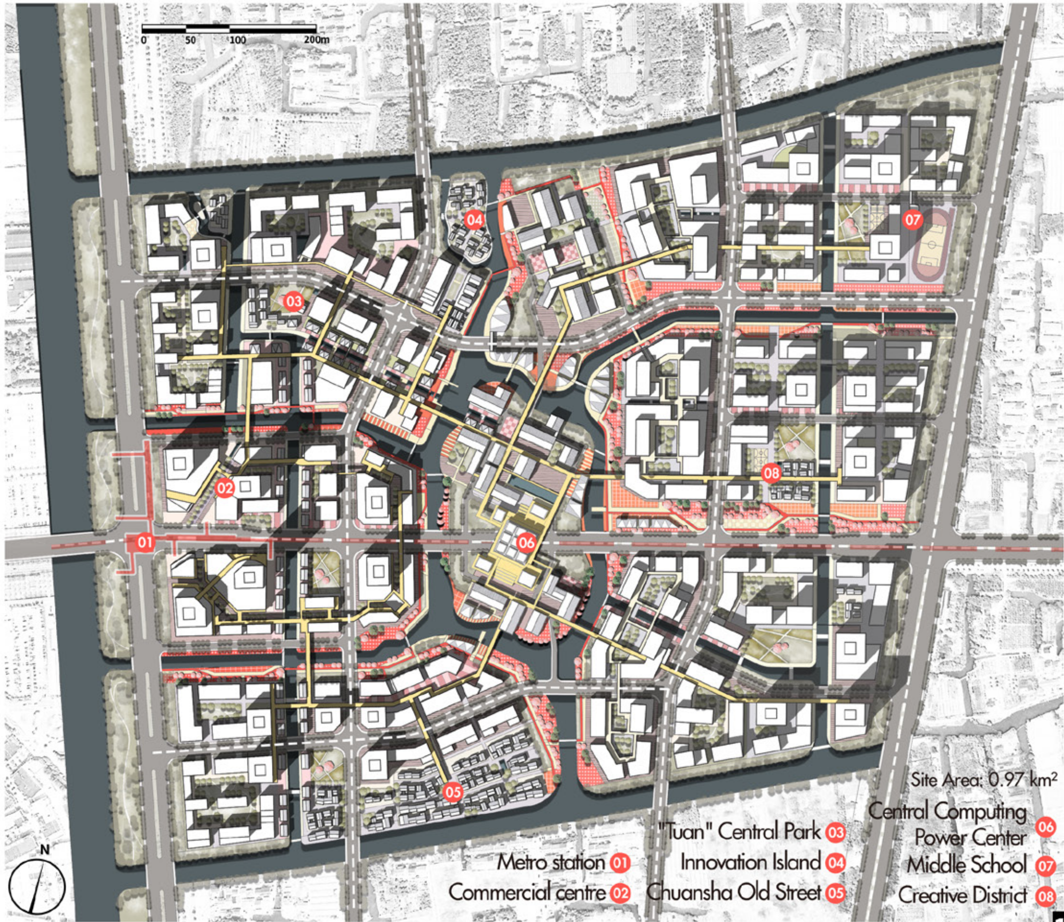
Development of City Spatial Layout & Functional Layout



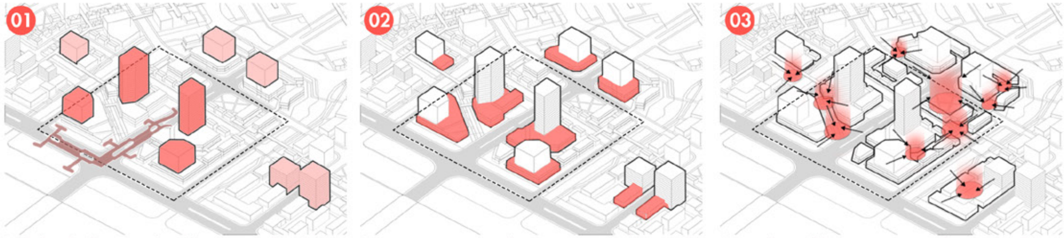
Overall Urban Design Structure



Master Plan of Urban Design



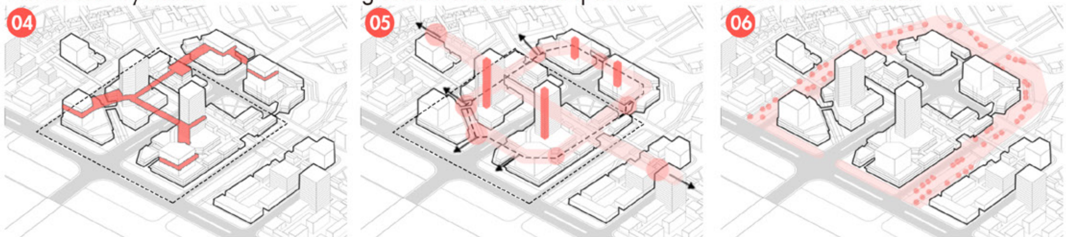
The Planning Components of the New "Tuan"



Link high-density development closely with the subway station.

Boost service and economic vitality with ground-level commercial spaces.

Provide public recreational spaces that connect different areas.

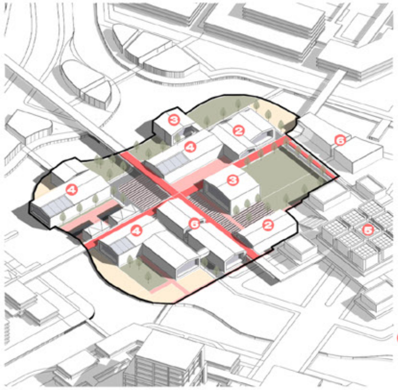


Set up shared public facilities in different zones to promote interaction.

Create internal pedestrian corridors that extend to other "Tuan".

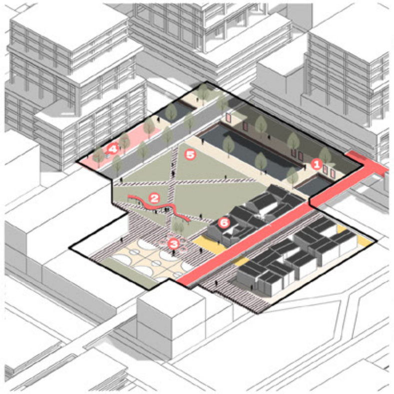
Incorporate wide ecological corridors in the external layout of the "Tuan."

Full Lifecycle Industry Chain Planning - Taking the Cultural and Creative Industry as an Example

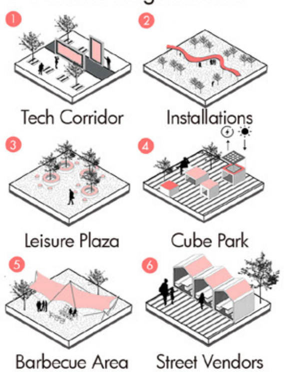


Upstream		Midstream		Downstream	
Cultural Materials		Design and Production		Sales Distribution	
Materials	Heritage	Design	Production	Online	Offline
Game Company Animation Studio Film & TV Company Cultural Heritage Inheritor Time-Honored Brand		Graphic Design Animation Design Industrial Design	Sample Production Mass Production	Content-based Ecommerce Private Domain Ecommerce Aggregated Ecommerce Traditional Ecommerce	Self-operated Model Consignment Sales Model Traditional Ecommerce
		Illustrator Designer Craftsman Creative Agency	Studio Factory Craftsman		
1 Disney Culture	2 Office Space	3 Essential Facilities	4 Production Space	5 Data Center	6 Live Streaming Facilities

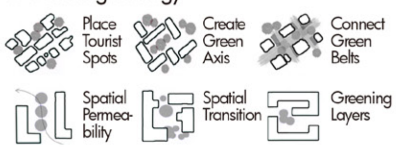
Ecological Space Utilization Planning



1 - Potential Usage Scenario

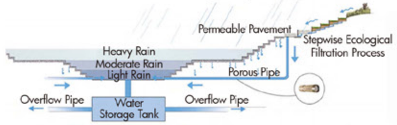


2 - Planning Strategy

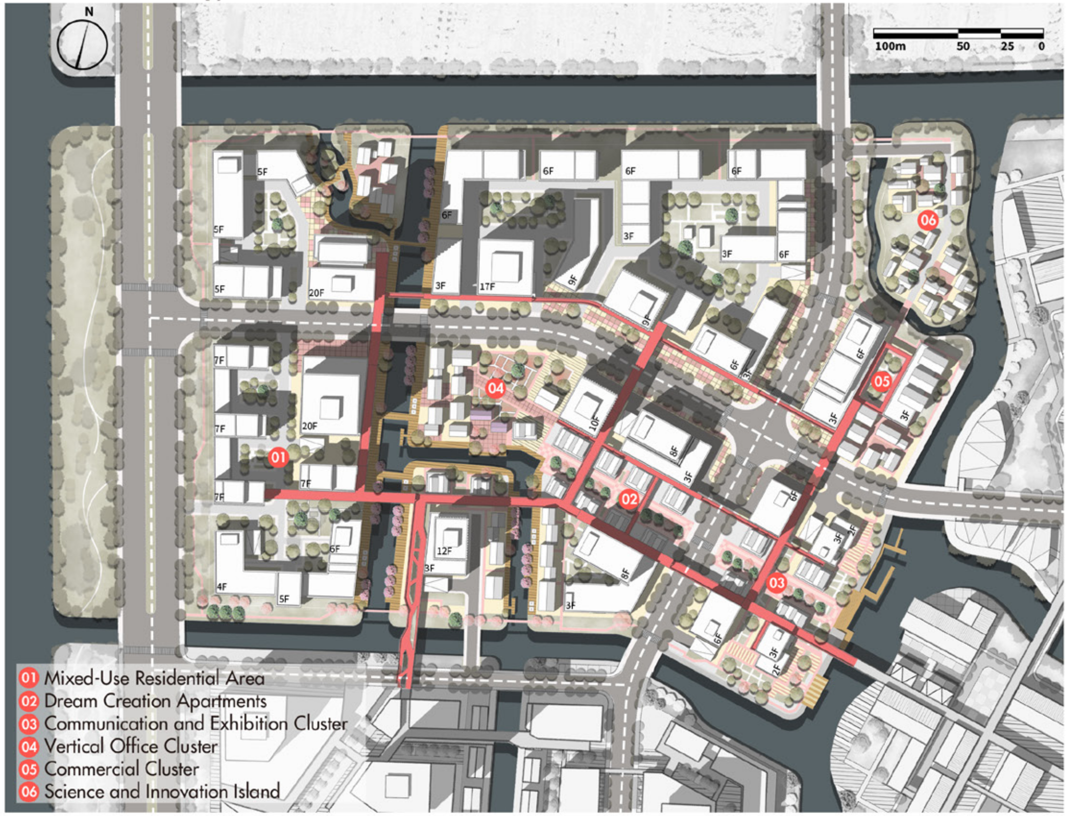


3 - Flood Control and Water Storage Strategy

The site is located near the coast and has a high-density water network system, so flood control and water storage must be considered in the ecological planning.

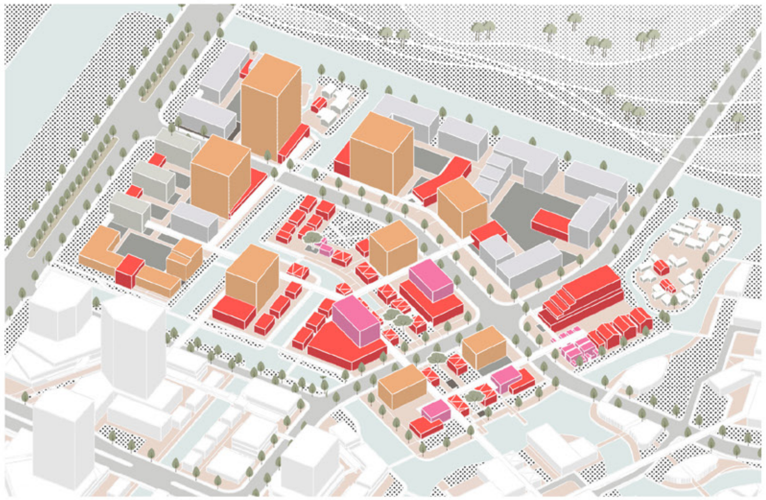


The Master Plan of a Typical New "Tuan"



Functional Mixed Layout

Proposed Functional Layout of the New "Tuan"



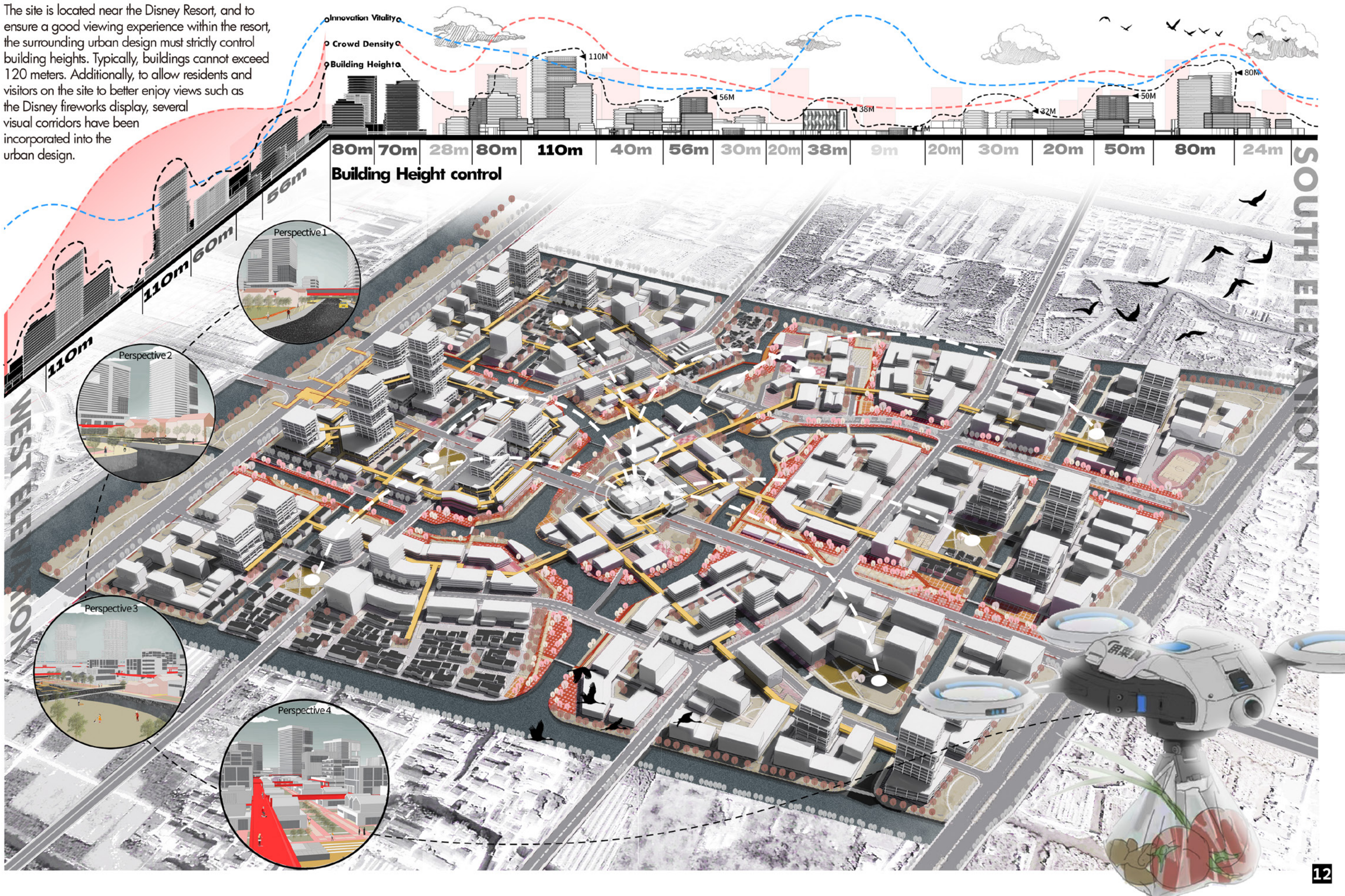
Industrial Cluster

Residential Cluster

Culture | Office | Commerce | Research | Residence

Urban Skyline and Vertical Development Control

The site is located near the Disney Resort, and to ensure a good viewing experience within the resort, the surrounding urban design must strictly control building heights. Typically, buildings cannot exceed 120 meters. Additionally, to allow residents and visitors on the site to better enjoy views such as the Disney fireworks display, several visual corridors have been incorporated into the urban design.



Home Above Market

"Ascending by Steps"

Housing Design

[Type] Architectural Design - Individual work

[Course] Interdisciplinary Studio (2) **[Time]** 09/2022 – 12/2022

[Author] Weikang Kong

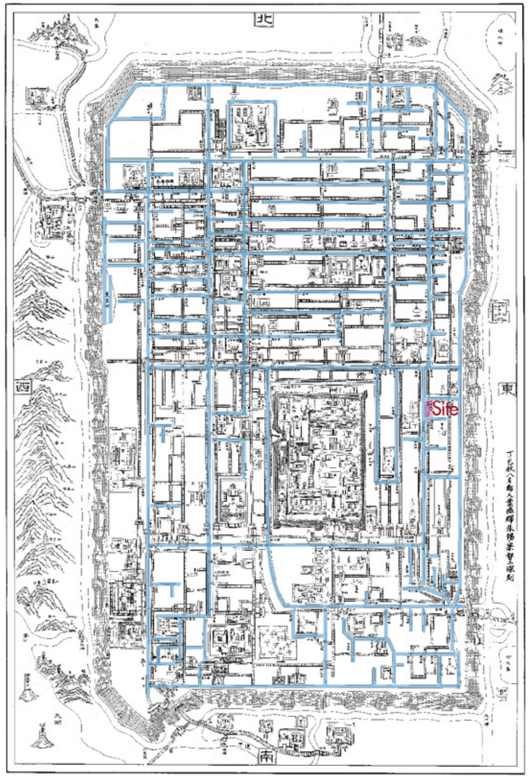
[Supervisor] Prof. Fangji Wang - Tongji University
Mrs. Beilei Fan - genarchitects
Mr. Bin Wang - Ge Bie Architecture Studio

SITE

Introduction

The Suzhou Twin Towers Food Market is about to undergo renovation, with the need to construct social rental housing that meets the diverse needs of different groups, based on the existing market. This design is grounded in Suzhou's traditional transportation organization and introduces a spatial section prototype. By creating platforms at different heights, this spatial relationship not only evokes the distant historical memory of the city, which once relied on waterway transportation, but also provides a better private living experience for the upper-level residences through elevation differences, while offering the lower-level market improved lighting and ventilation opportunities.

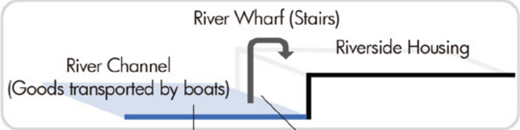
Design Concept and First Floor Plan

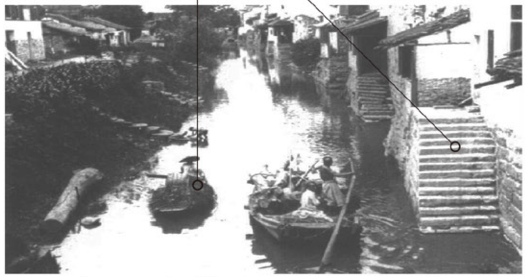


平江圖 Map of Pingjiang (Suzhou), Song Dynasty, 1229

Reflecting the complex historical Suzhou City water network system

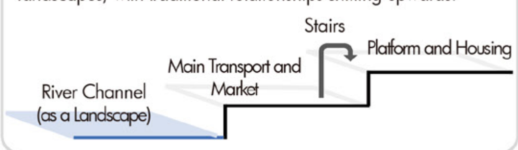
Traditional mode of transport and marketing in Suzhou:





Proposed new mode of housing: **City's Historical Memory**

Waterway transport landification: Rivers transform into landscapes, with traditional relationships shifting upwards.



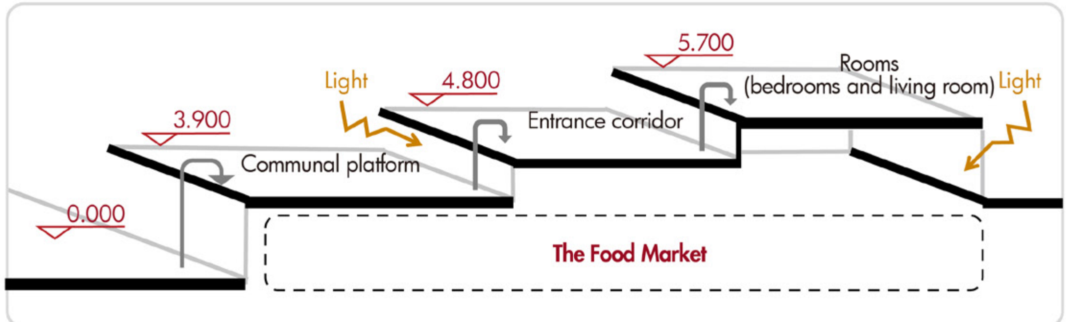
Disadvantages of the existing residential communal platform solutions

Hard to distinguish public and private spaces in housing.

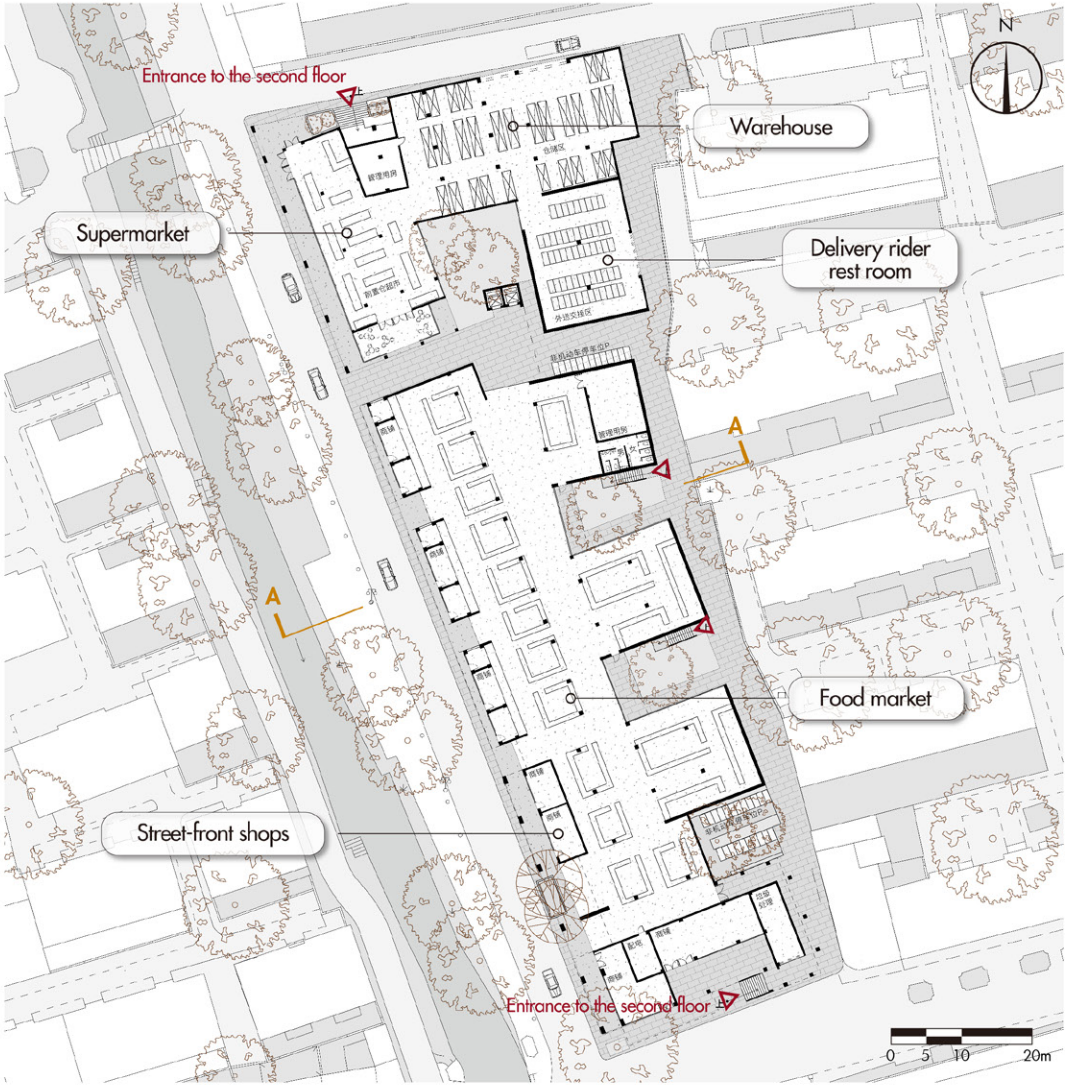
Challenges in meeting the privacy needs of residents.

Poor natural lighting in the market.

Conceptual Section Steps provide both privacy to the residents and natural light to the food market.



First floor plan



Section A - A Waterway transport landification offers new spatial possibilities, awakening the city's historical memory.

Stepped Section and Housing Units

2F Communal platform

All the residences are linked by a large platform, with an elevated staircase leading to their home. The platform and the homes are reminiscent of the waterways and river docks in Suzhou.

Section B - B

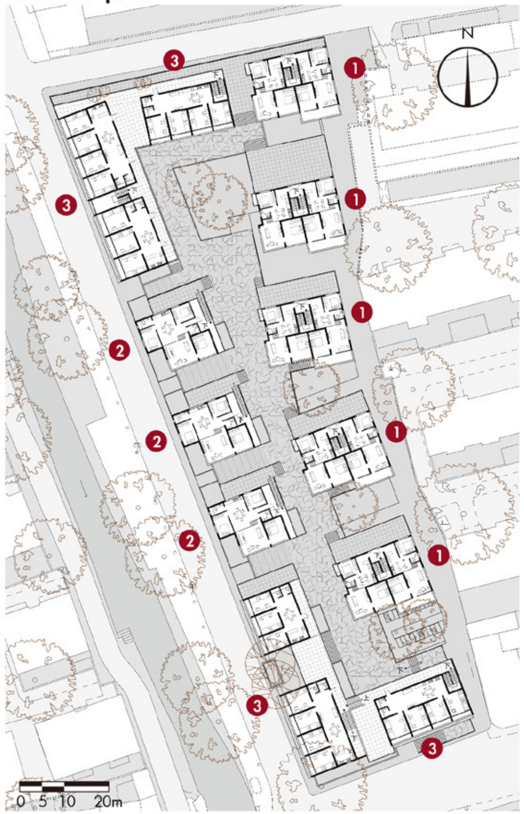
The stepped section not only enhances natural light for market but also improves privacy for the residents. The elevation changes also add interest to the interior space of the residence.

1F Food market

The elevation of the second floor also creates more space and natural light for the market on the first floor. Residents can easily observe the market activities, adding a sense of liveliness to their daily lives.

Second floor plan

Third floor plan



1

Unit 1 For Entire Rental

80 m² or 90 m² (with balcony)
2 Bedrooms, 1 Bathroom, 1 Living Room

On the interior side with less disturbance
West-facing views with scenic sights

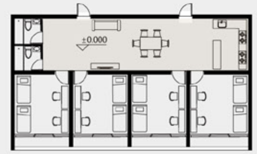
2

Unit 2 For Entire Rental

126 m²
3 Bedrooms, 2 Bathroom, 1 Living Room

On the outer side with scenic sights
Better natural light in the living room

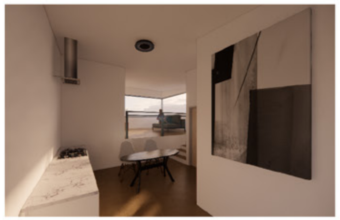
3



Unit 3 For Shared Rental

25 m² x 4 (or 3) + 52 m²
4 Bedrooms, 2 Bathroom, 1 living Room

On the outer side with scenic sights
Shared living space and bedrooms



Under Water Pressure

Sports Complex - Structure Design

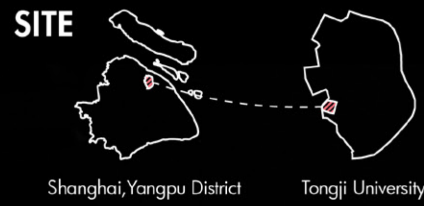
[Type] Architectural Design - Group work **[Time]** 04/2023 – 06/2023

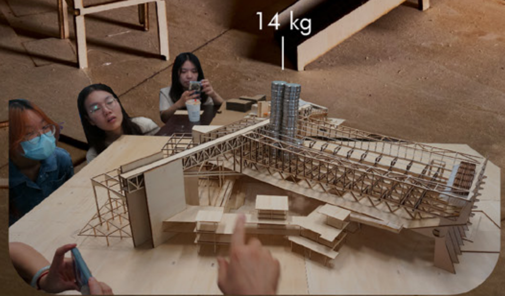
[Course] Interdisciplinary Studio (4)

[Author] Weikang Kong, Zhenyuan Zhang, Yanzi Jin, Mengfei Zhao

[Contribution] Team leader, Conceptualization, Structure design, Structural model

[Supervisor] Prof. Zhun Zhang - Tongji University Prof. Fangji Wang - Tongji University
Prof. Ting Zhang - Tongji University





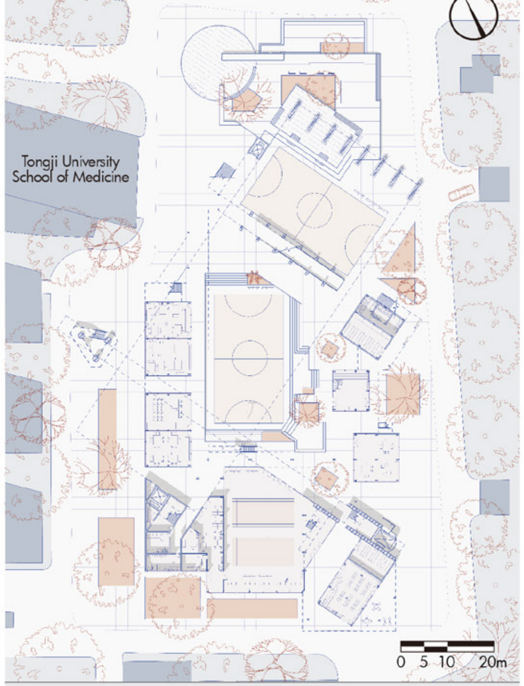
Weight loading test for 1:50 model

Introduction

The existing swimming pool and gym at Tongji University can no longer meet the growing and diverse activity needs of students. This design proposes the reconstruction of a sports complex on the original site, integrating various sports facilities and student organization spaces. The strict area and height requirements for sports venues make vertical stacking and large spans inevitable. The design introduces an innovative lever-like structural approach, elevating the pool to enhance the swimming experience while organizing club activities within the structure, achieving an highly open ground level and spatial integration.

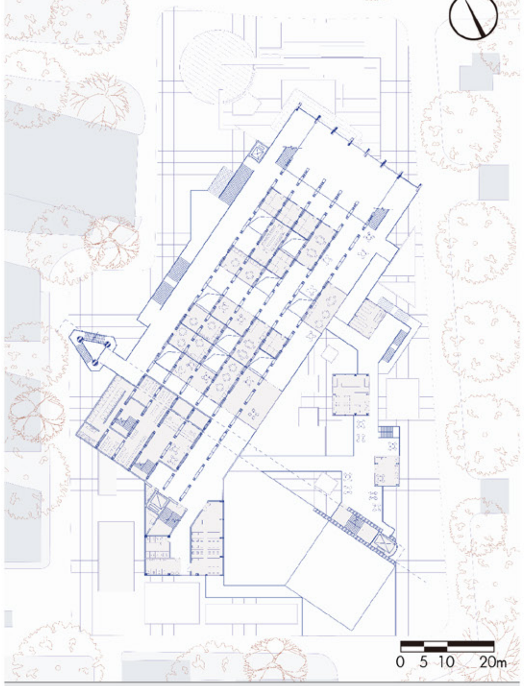
Architectural Layout and Functions

First Floor Plan



The ground floor is open with two basketball courts, club activities spaces, and a high-ceilinged badminton court on the south side.

Third Floor Plan



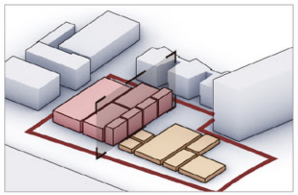
The main structure, composed of trusses, is hollow. Using algorithmic rules, it houses most club activities and pool maintenance equipment.

Functional requirements: Activity types and space needs of student organizations

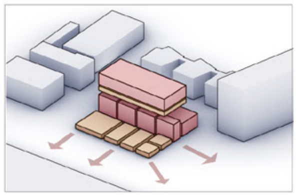
- Arts & literature
- Academic studies
- Innovation & entrepreneurship
- Public welfare
- Sports

- Practice and performance spaces ~400 m²
- Study and discussion spaces ~800 m²
- Storage spaces ~300 m²
- Specialized sports spaces ~8000 m²

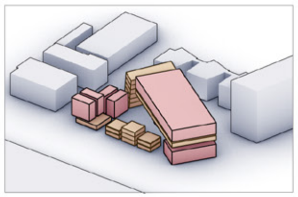
Design logic: Use structural methods to achieve the composite stacking of different spaces.



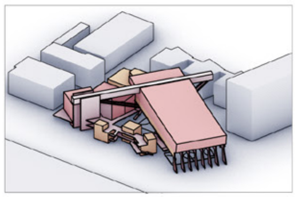
Step 1
Determine the volume of different types of spaces based on area and height requirements.



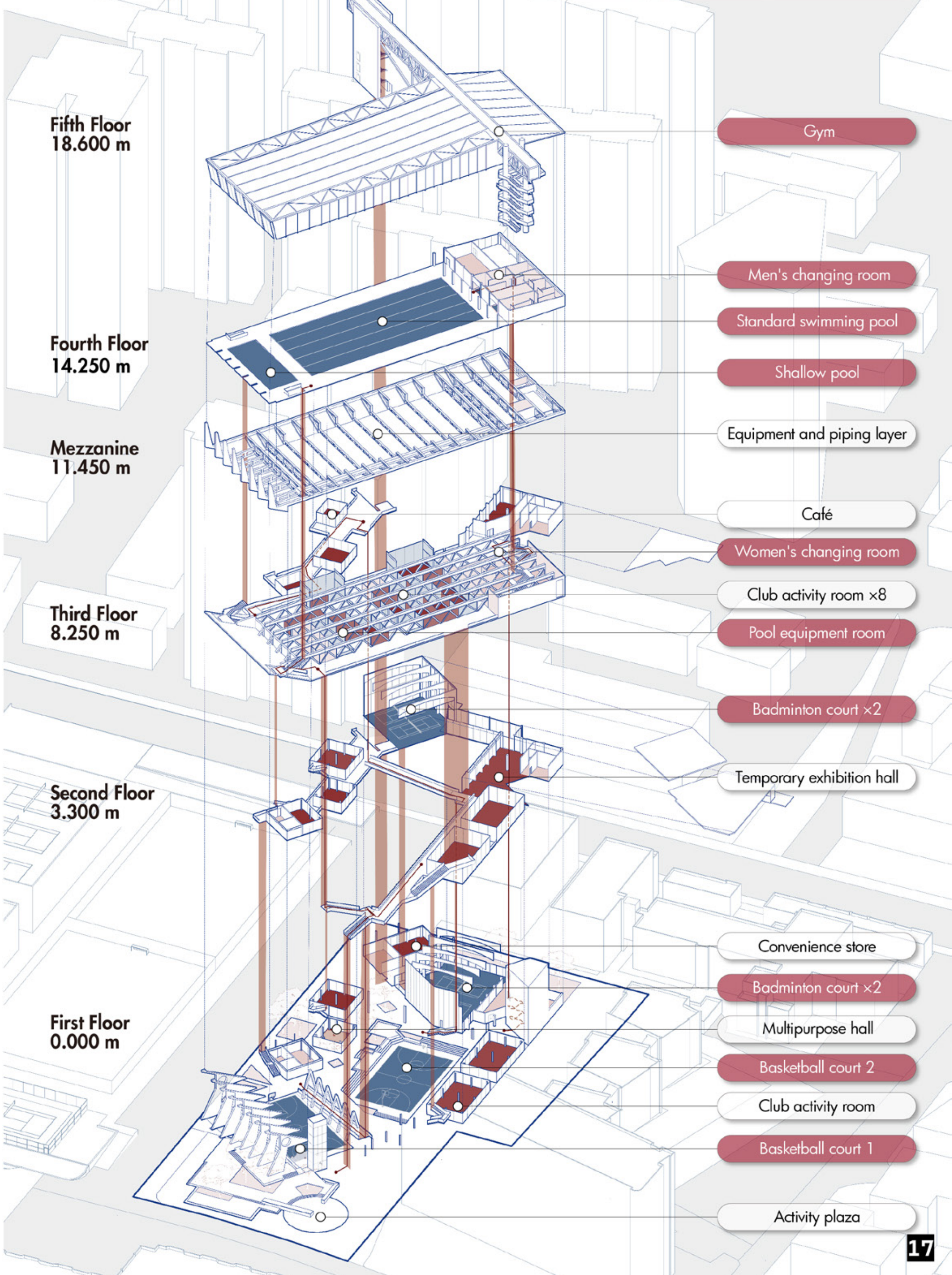
Step2
Elevate the pool to achieve an open ground level and mixed space functions.



Step 3
Rotate the pool volume to create space and reduce the height of the maximum span.



Step4
Integrate the structure and circulation systems to connect all functions.



The Structure for Space and the Space of Structure

14.250 m
Swimming Pool

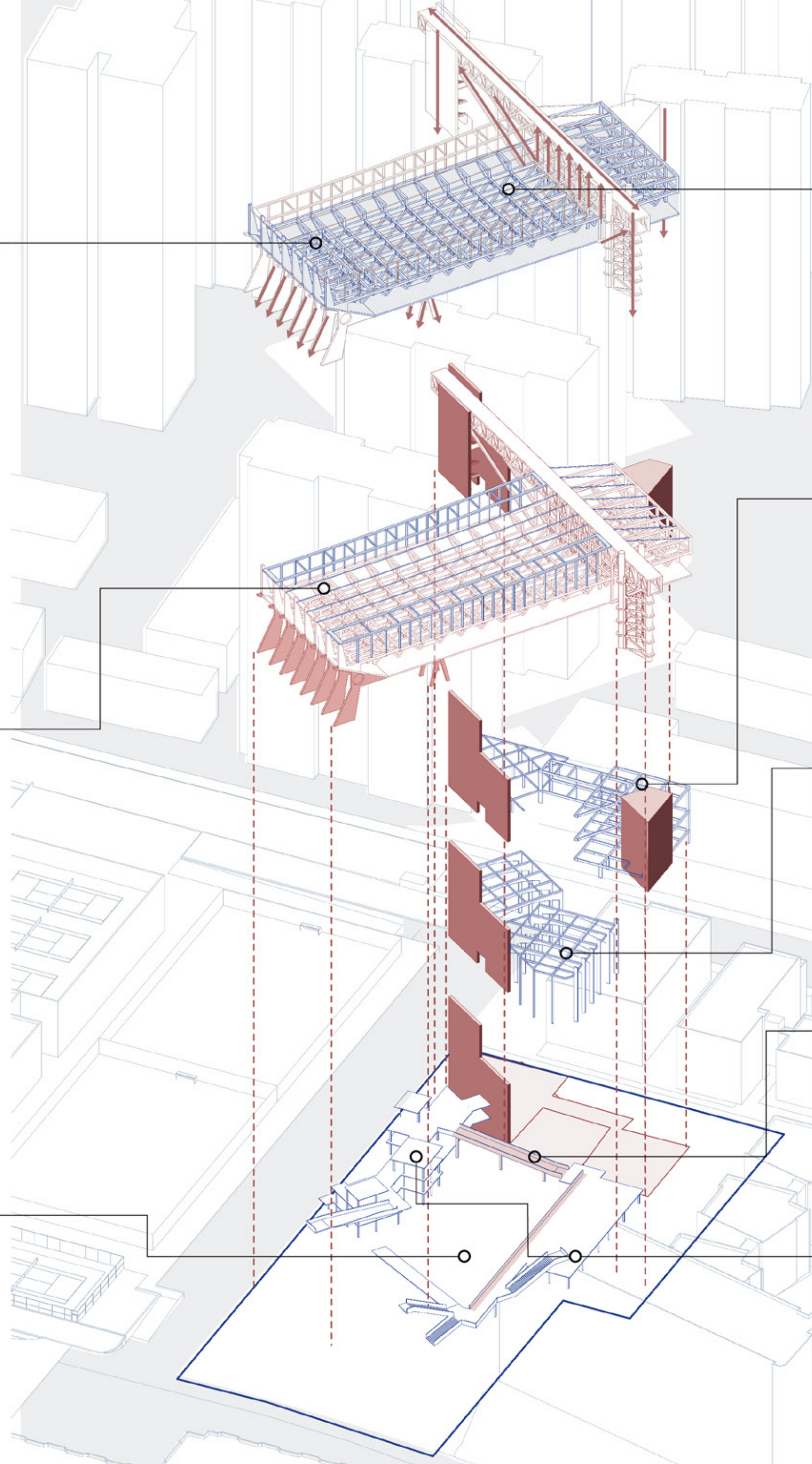
The massive structure supports the swimming pool, which is extremely heavy due to the water it holds. The pool on the top floor offers the most expansive views and the best swimming experience. The roof is designed to be retractable, with a cable-suspension system and sliding tracks enabling it to open and close.

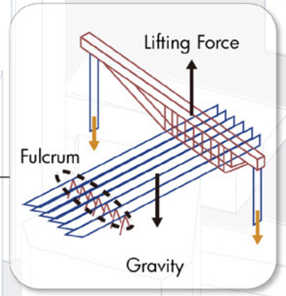
8.250 m
Club Activity Space

The vertical span of the structure is supported by large trusses, and the internal space of the V-shaped trusses can be divided for various uses. Some of the flooring has been removed, as it does not affect the structural load, creating a more open and dynamic spatial experience.

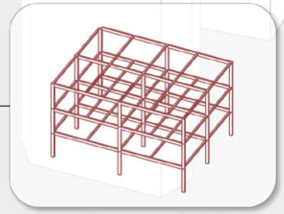
0.000 m
Sports Ground

The massive structure creates a large, column-free space on the ground floor, providing shelter from the rain and accommodating various sports activities, such as basketball. This space is surrounded by smaller activity spaces, fostering a lively atmosphere.



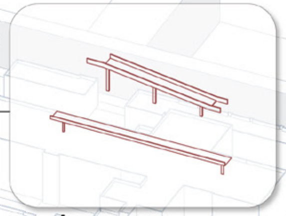


Simplified Structural Model the Lever Structure

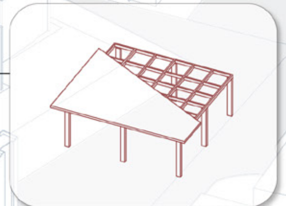


Frame Beam and Column System

Arched Door Frame Structure



Railing as a Large-Span Cantilever Beam



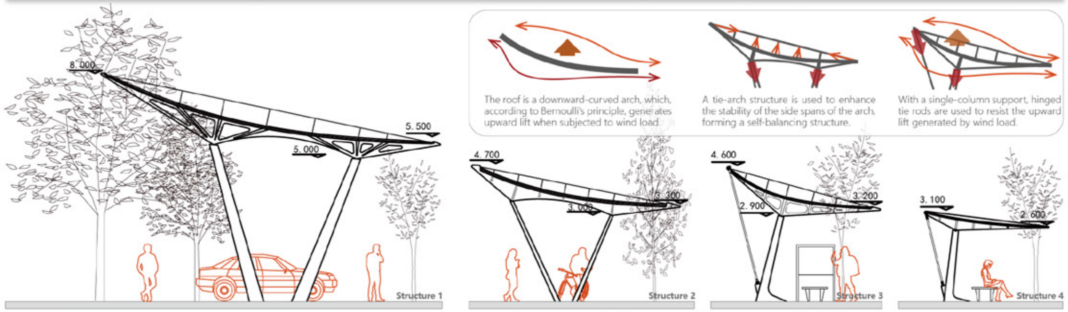
Miller Beam and Thick Plate Structure

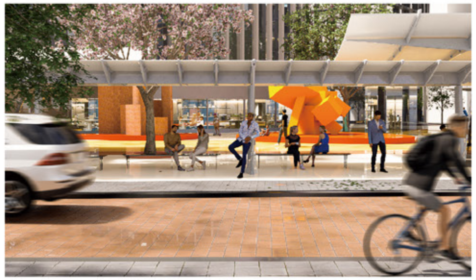
Other Works

Competition Works

Waving & Soaring, 2024

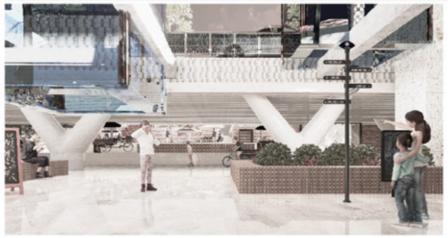
The Silver Award of Competition of Metaverse IP and Space Design for Dongmen (2nd of all submissions)

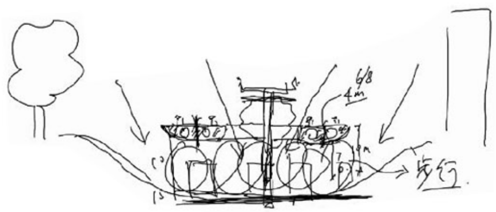


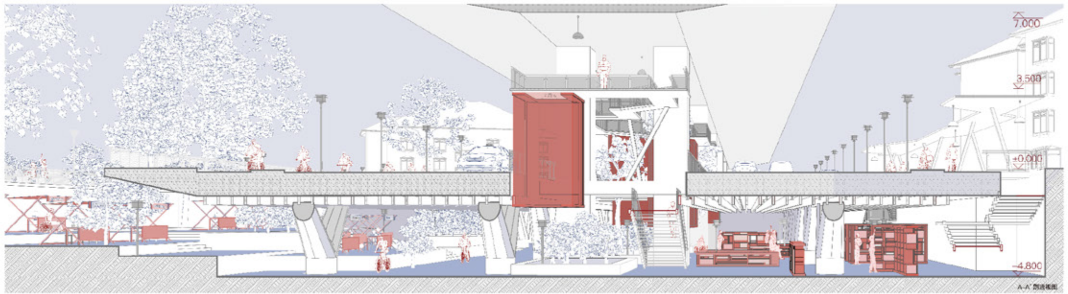


Parcel Hub Under the Highway, 2023

The First Prize of the 10th International Architecture Design Competition for College Students of Teamzero Award (1st of 683 submissions)

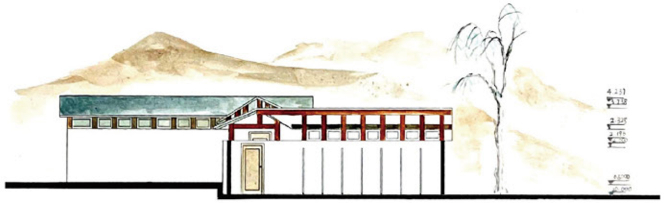






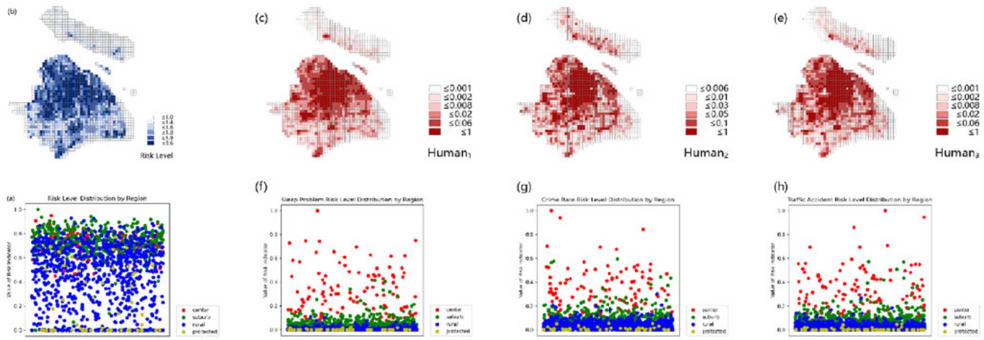
Bathhouse Design for Rural Primary School, 2021

Fumei Charity Bathhouse Design Competition for Rural Primary School



Research Paper Challenge on Urban Light Pollution Risk Estimation "Fade Away with Stars", 2023

Honorable Mention Prize of Interdisciplinary Contest in Modeling (ICM) (TOP 15%)



Unmanned Aerial Vehicle Formation Flight Adjustment Method Based on Bearing-only Passive Location, 2022

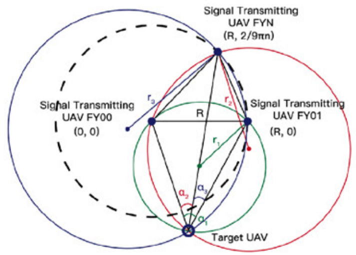
The First Prize of Contemporary Undergraduate Mathematical Contest in Modeling (TOP 10%)

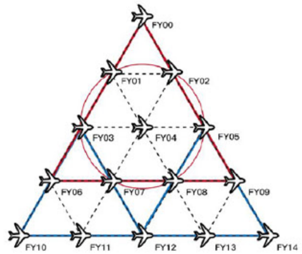
$$\begin{cases} \frac{R}{\sin 2\alpha_1} = \frac{r_1}{\sin(\frac{\pi}{2}-\alpha_1)} \\ (R-x_1)^2+(0-y_1)^2=r_1^2 \\ (0-x_1)^2+(0-y_1)^2=r_1^2 \end{cases}$$

$$\begin{cases} \frac{R}{\sin 2\alpha_2} = \frac{r_2}{\sin(\frac{\pi}{2}-\alpha_2)} \\ (R\cos\frac{2}{9}\pi n_1-x_2)^2+(R\sin\frac{2}{9}\pi n_1-y_2)^2=r_2^2 \\ (0-x_2)^2+(0-y_2)^2=r_2^2 \end{cases}$$

$$\begin{cases} \frac{R}{\sin 2\alpha_3} = \frac{r_3}{\sin(\frac{\pi}{2}-\alpha_3)} \\ (R\cos\frac{2}{9}\pi n_2-x_3)^2+(R\sin\frac{2}{9}\pi n_2-y_3)^2=r_3^2 \\ (0-x_3)^2+(0-y_3)^2=r_3^2 \end{cases}$$

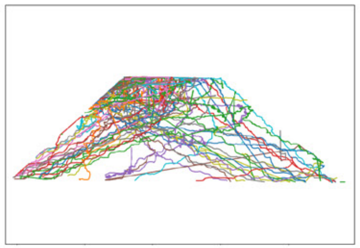
$$\begin{cases} 2r_4\sin(\alpha_4)=\sqrt{2(1-\cos(\frac{2}{9}\pi n_2-\frac{2}{9}\pi n_1))} \\ (R\cos\frac{2}{9}\pi n_1-x_4)^2+(R\sin\frac{2}{9}\pi n_1-y_4)^2=r_4^2 \\ (R\cos\frac{2}{9}\pi n_2-x_4)^2+(R\sin\frac{2}{9}\pi n_2-y_4)^2=r_4^2 \end{cases}$$





Research on the Influence of Spatial Factors on Pedestrian Flow, 2021

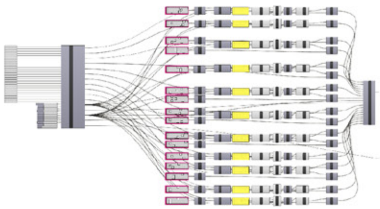
The First Prize of 7th Tongji University Innovation Academic Forum (Top 10 of 74 projects)

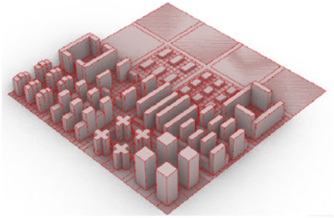


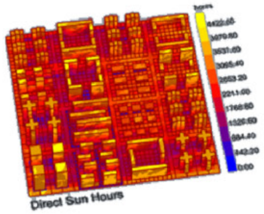
Academic Works

Random City Form Generator, 2023 Workshop Project, Supervisor: Jiawei Yao

Using Grasshopper programming, a city form generator is created with 11 types of buildings. The height, width, and length of the buildings, as well as the number of blocks and road widths, are adjustable. The system can be used for wind and thermal environment simulations.

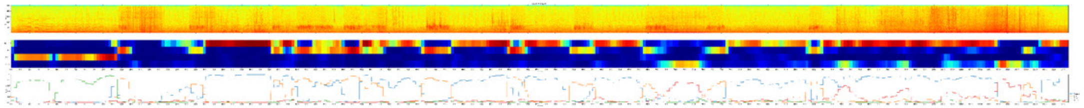


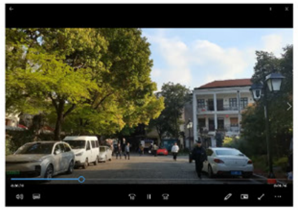


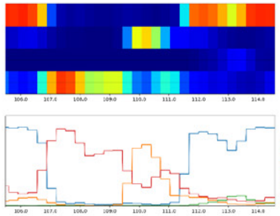


Soundscape Dectector, 2023 Course Project, Supervisor: Yujia Zhai

Using a modified PANNs model, the dectector recognizes common sounds on different roads through recorded videos, quantifying indicators such as duration, frequency, and loudness of their occurrence.

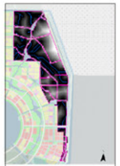






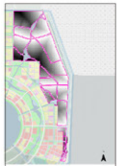
Optimal Incremental Land Development Site Selection Model, 2023 Course Project, Supervisor: Xinyi Niu

Based on overlay analysis and AHP method, using ArcGIS Pro software, the model is applied to determine the optimal location for incremental land development in the master plan of Nanhui New City, Shanghai.

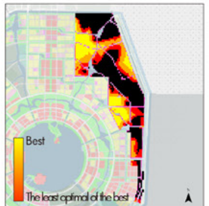

Criterion A1


Criterion A2

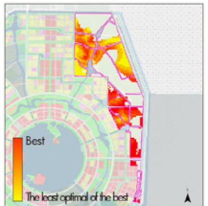

Criterion B1


Criterion B3

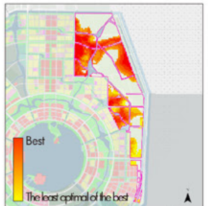

Criterion C2



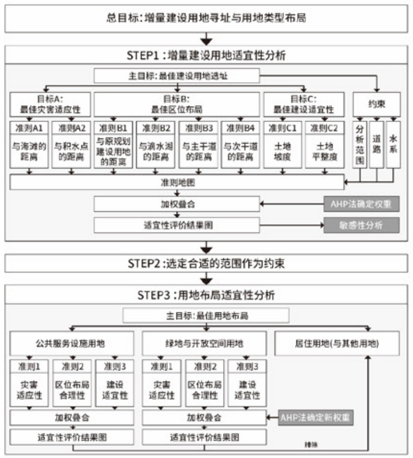
Optimal Site Selection



Optimal Site Selection for Service Facilities



Optimal Site Selection for Green Spaces

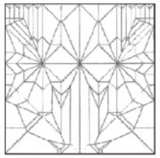


Personal Interests

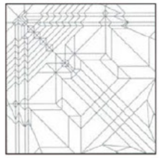
Origami Works, Since 2020

A traditional Asian art of folding a (square) sheet of paper into intricate shapes and designs without using scissors or glue.

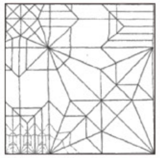
Nazgul

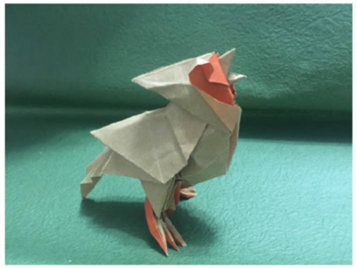


Lion

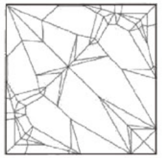


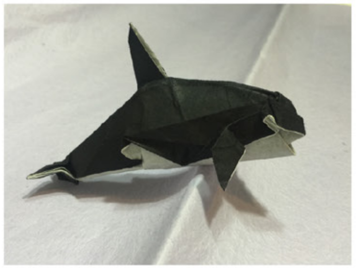
Cardinal





Orca





Phoenix

Extracurricular Activities

Extracurricular Course Coordinator for Junior High School, 2024

Part of course outcomes of semester-long interest courses for junior high school students