DigitalFUTURES2022 / MetroDataTech · Intelligent Logistics System under the Perspective of Big Data

Analysis of the Spatial Distribution of Express Courier Stations and Assessment of Site Selection Effectiveness

——A case study of Cainiao courier stations in the central area of Shanghai

Analysis and evaluation of the current location of courier stations within the city

In-City Express: Distribution Centers / Business Networks

Goods: Logistics and Transportation

People: Built Environment

· How is the layout of the Cainiao courier stations in Shanghai?

· Is there room for optimization of the layout?

· Newer goals, fewer studies

· Existing studies focus on layout description and qualitative analysis

Finding patterns in evolution and current situation

Research Object: Directly operated Cainiao courier stations with both self-pickup and delivery services

Research Question:
1. In the face of the increase in delivery costs, how are Cainiao courier stations laid out in cities?
2. How should new courier stations be located?

Problem Dismantling: Analyze layout characteristics ①, identify influencing factors and models ②, and conduct current effectiveness analysis / site selection guidelines ③.

Scale	Problems	Objects
Macro	Characterizing the spatial and temporal evolution of courier station distribution.	Shanghai city area (except islands)
Meso	Identify meso-influential factors and models that are "fit for station" and evaluate the supply and demand for street-scale station layouts.	Shanghai central area (Street Administrative Area)
Micro	Identify micro-environmental characteristics "fit for station" and propose an effectiveness evaluation of the current situation based on specific indicators.	Individual station locations

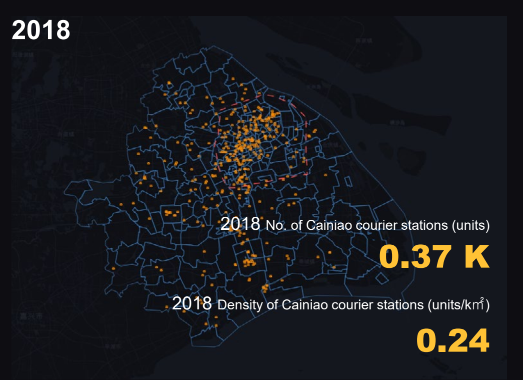
Datlas-based courier station siting platform construction

Macro Layout Features

Volume Distribution - Significant Increase in Volume

In 2018, the Cainiao courier station layout in Shanghai was primarily concentrated in the city center, adopting a "single-core" configuration with the highest station density. However, by 2022, the distribution of Cainiao stations in Shanghai had become more dispersed.

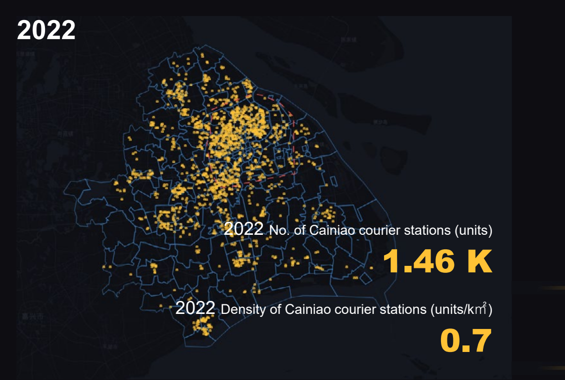
2018



2018 No. of Cainiao courier stations (units) **0.37 K**

2018 Density of Cainiao courier stations (units/km²) **0.24**

2022



2022 No. of Cainiao courier stations (units) **1.46 K**

2022 Density of Cainiao courier stations (units/km²) **0.7**

Increase over 2018 (units) **1.09 K**

Increase over 2018 (units/km²) **0.46**

Spatial Distribution - Diffusion Trend, Suburbs Growing at a Significantly Higher Rate than Central Areas

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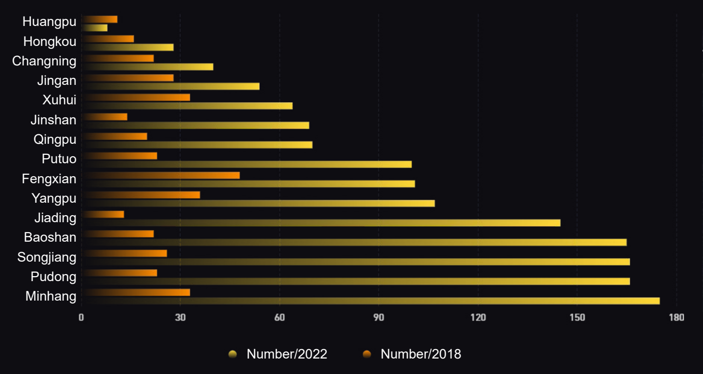
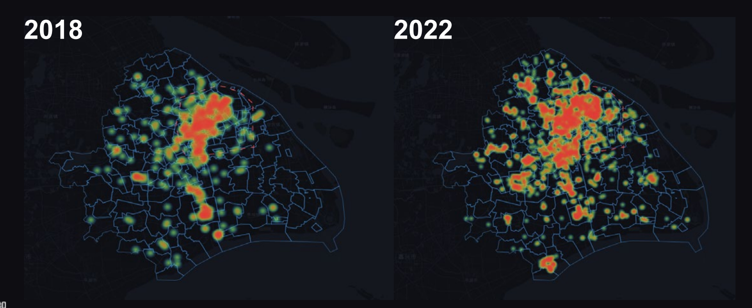
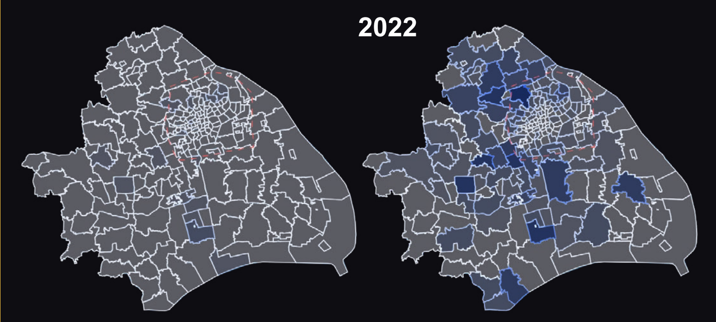




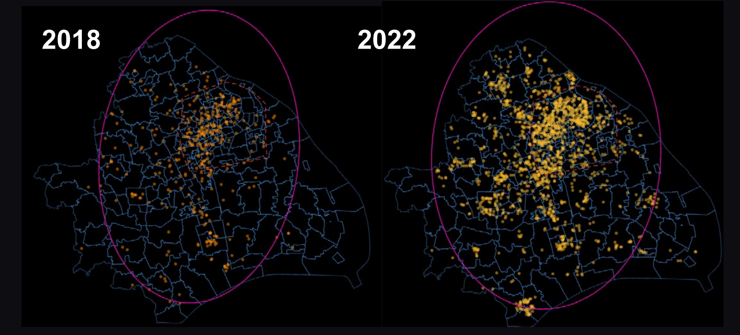
Street Level - The Number of Stations in the Streets around the Outer Ring has Increased Significantly

Compared with 2018, the number of Cainiao courier stations in the towns and cities around the Outer Ring Highway in 2022 increased significantly, with the most significant increases in Dachang Town in Baoshan District and Xinzhuang Town in Minhang District.



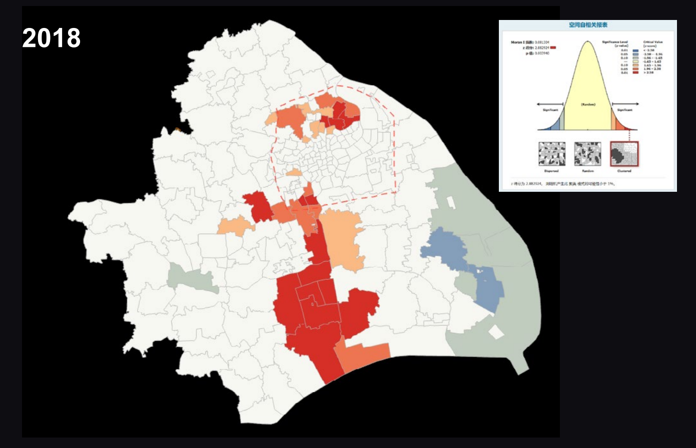
Directional Distribution - Full Diffusion with Reduced Directionality

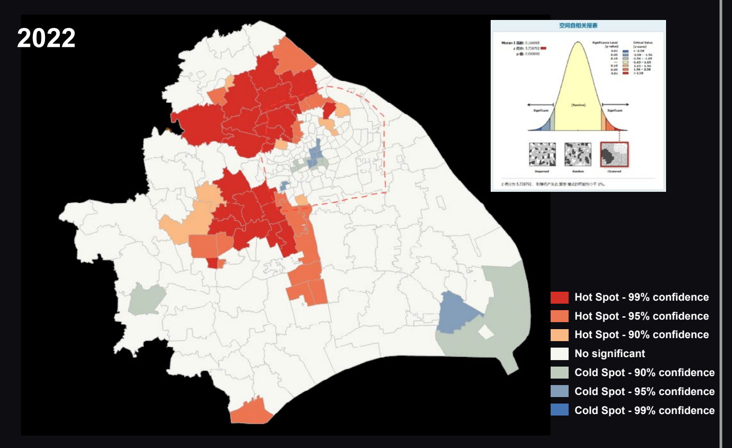
Compared with 2018, the service scope of Shanghai's Cainiao courier stations was expanded and the directionality was weakened in 2022; the center of the distribution was located near Hongqiao Street, and the clustering area was roughly distributed in the northeast-southwest.



Spatial Autocorrelation Analysis - Suburban Gathering

The spatial distribution of Cainiao courier stations in both 2018 and 2022 was characterized by significant clustering. Compared with 2018, the clustering was enhanced in 2022, with high-value clusters forming in some streets in Baoshan District, Jiading District, Songjiang District and Minhang District around the Outer Ring Highway; low-value clusters mainly appeared in the city center, Huangpu District, and in some streets close to the administrative boundary of Shanghai.

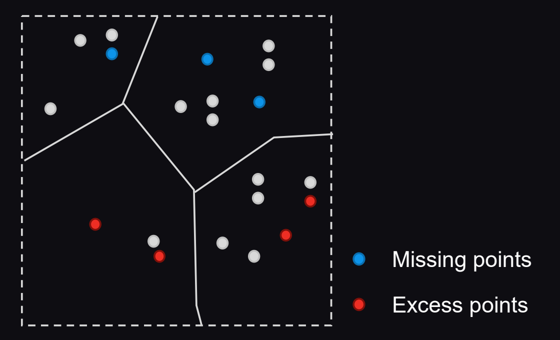




Meso Supply and Demand Analysis

Meso scale - Identifying External Influences that are "Fit for Station"

Hypothesis: at the meso-scale, the distribution of Cainiao courier station configuration was related to the external environment with some regularity.



Geographically weighted regression with streets as statistical units - Significant outliers: oversupply or undersupply

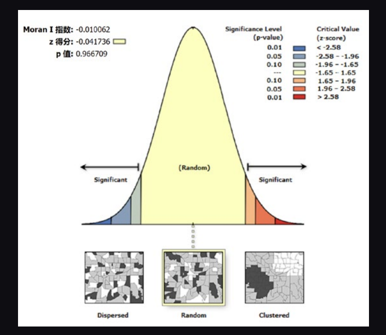
Independent variables:

Population: Categorized population size
Transportation: Road network density / Public transportation stations
Living standard of residents: Number of amenities / Housing prices
Urban Functions: Number of neighborhoods / Number of businesses

Dependent variable:

Number of Cainiao courier stations distributed on the street

$R^2 = 0.78$



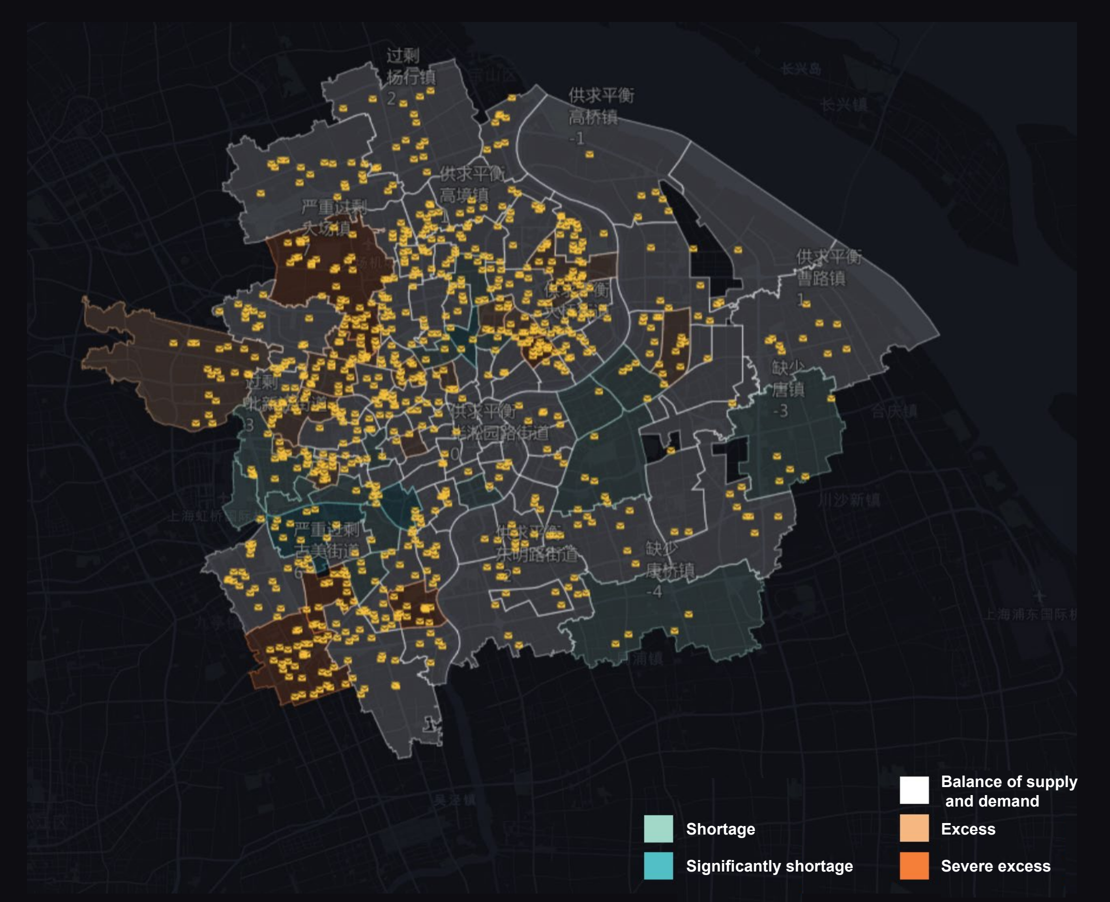
High confidence in results

Results

Population, Number of neighborhoods ⇨ Neighborhoods

Road density, Housing price, Proportion of foreign population, Proportion of youth ⇨ Suburban housing

↑ Number of neighborhoods
↑ Proportion of foreign population and youth
↓ Road density
↓ House price



Decision to open a Cainiao courier station

Increase

Optimization

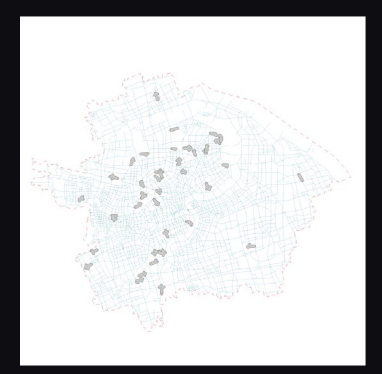
Micro Influencing Factors Analysis

Micro scale - What is a good courier station layout?

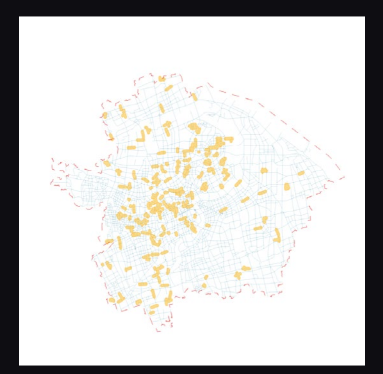
Hypothesis: at the micro-scale, the siting of courier stations was changing towards a more optimal direction.

What micro-environmental features around the courier stations changed as it "lived" and "died"?

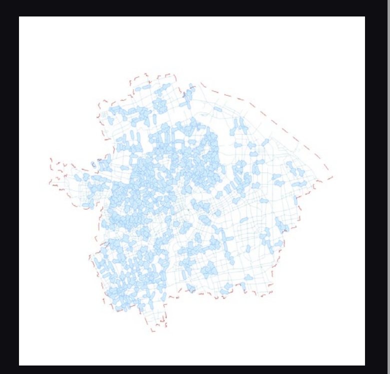
Reservation courier stations: 43



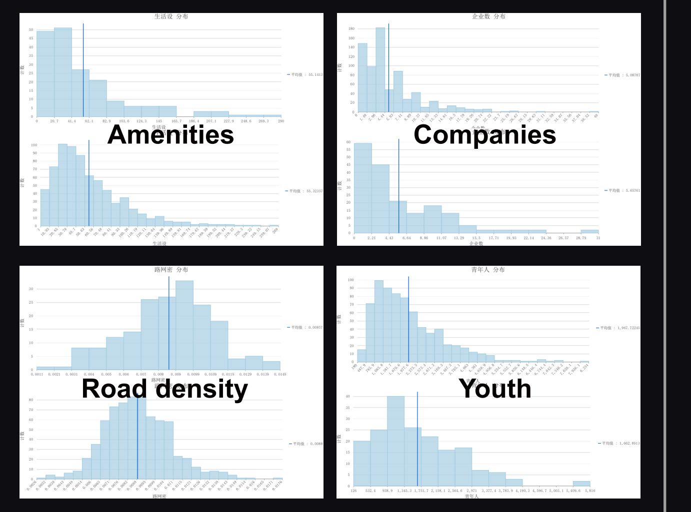
2018 courier stations 500m isochronous circles



2022 courier stations 500m isochronous circles



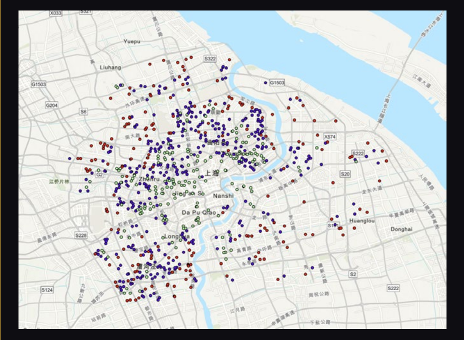
Indicator	2018	2022
↑ Number of amenities	55.14	55.32
↑ Number of bus stops	8.2	9.9
↓ Number of companies	5.65	5.08
↑ Road density	0.0085	0.0088
↑ Population of youth	1663	1967
↑ Population of middle-aged people	5787	7480
↑ Population of elderly	4653	6160



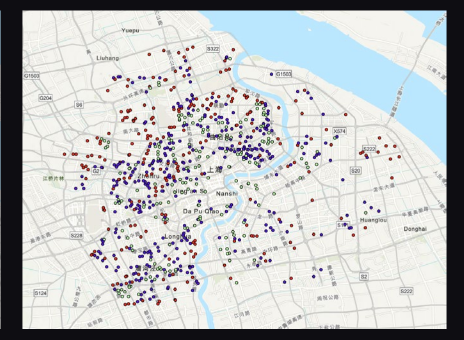
Function: Away from companies and businesses and towards residential areas

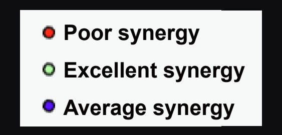
Space: Relocation to areas with high concentration of amenities and bus stops

Number of surrounding amenities - Amenities Synergies



Number of surrounding bus stops - Bus Stops Synergies





Micro-layout Effectiveness

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Data Source:
· 2018 Cainiao courier stations data: Peking University Open Data Platform | Gaode POI
· 2022 Cainiao courier stations data: self-collected during the workshop| Gaode POI
· Housing price data: Chain Home website in November 2021
· Population data: provided by the workshop
· Amenities data: provided by the workshop