

Validating overbuilding of shopping centers in Shanghai and identifying which with investment potential

Chi Zhang

Master student of Urban Spatial Analytics

Introduction and Motivation

At present, number of shopping centers opened or to be opened in Shanghai will be as high as 419. For 2020, The area of shopping centers per person is 0.97m^2 . Both count and area of malls are dramatically increasing since 2009. Considering the consumption capabilities, the supply area of shopping centers in Shanghai is almost 3 times of that in the United States. Overbuilt may cause severe energy waste and disturb the social economics.

This research aims to build a computational model to identify overbuilt malls and validate the result with social media data. For the overbuilt malls, a regression model is built to extract surplus shopping centers with investment potential for future regeneration or redevelopment.

For government, it is necessary to take actions to control over development of real estate. Instead of continuing to plan new commercial land with ignorance of real demand, it is more important to find and activate surplus shopping centers. For real estate investors, this paper offers an efficient tool to identify surplus shopping centers in a relatively good location. Investors could acquire these assets at a lower price and create values with better operation and marketing strategies.

Fig1. Booming of shopping centers since 2009

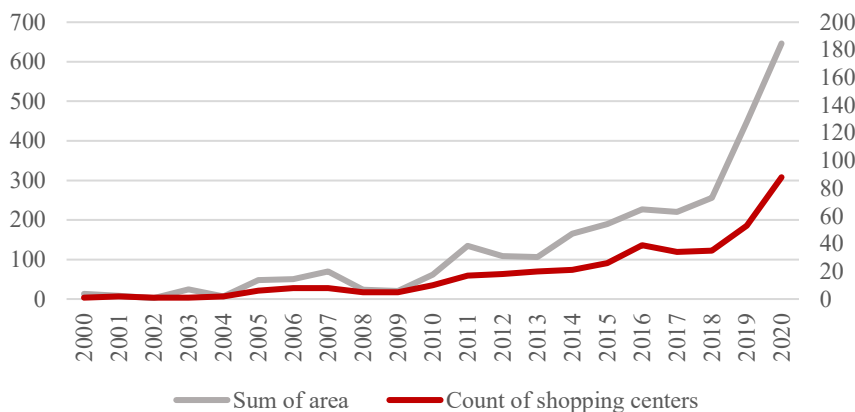
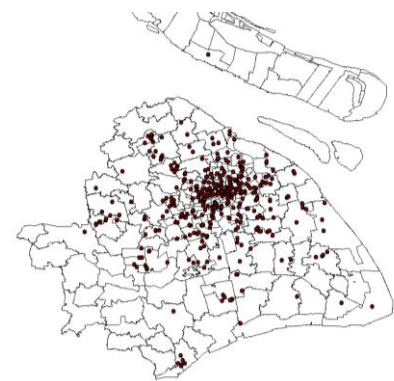
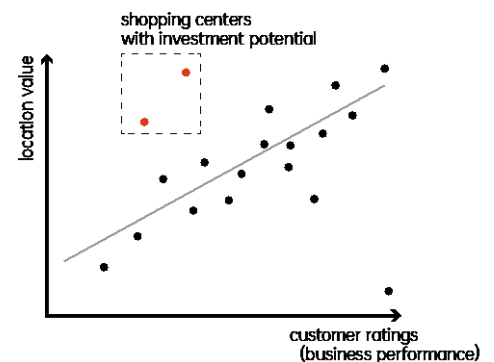


Fig 2. Shopping center points



Question

- 1) If overbuilding shopping centers exist in Shanghai? (There is not a widely accepted definition. In this research, malls with potential income below operating costs are defined as overbuilt)
- 2) Identify the shopping centers with investment or improvement potential. (Overbuilt malls with good location but poor operation)



Literature Review

Over development is an urban issue that real estate supply beyond local demand. It's related with China's real estate dominated economic structure and may bring negative economic and social impacts. Wan Dong (2010) analyze the behavior of local government and real estate development and believes real estate over-development does harm to social welfare. J Li (2018) stated that over development has an inhibitory effect on private investment through vampire effect, raising costs and reducing demand effect. In recent year, over development of residential market in China is validated by many researchers. In 2019, MIT Civic Data Design Lab built a model to identify ghost cities(underused residential areas) using social media data. Noticeably, since there is not a standard definition of ghost city, this paper validate model based on subjective judgement. This research is with similar situation. Does this problem also exists in other real estate types, like commercial, industry, office etc. Currently, there is no quantitative research on these topics. In western countries, it is common to control development area based on an econometric demand model. For instance, Robert M. Lillibridge(1952) came up with a method to estimate shopping center area income and population data, which is still widely used by planners.

In conclusion, overdevelopment brings negative economic and social effects. There are researchers validated overdevelopment of residents in China. This paper fills the research gap of shopping center over development and build a tool to identify surplus area at a building scale.

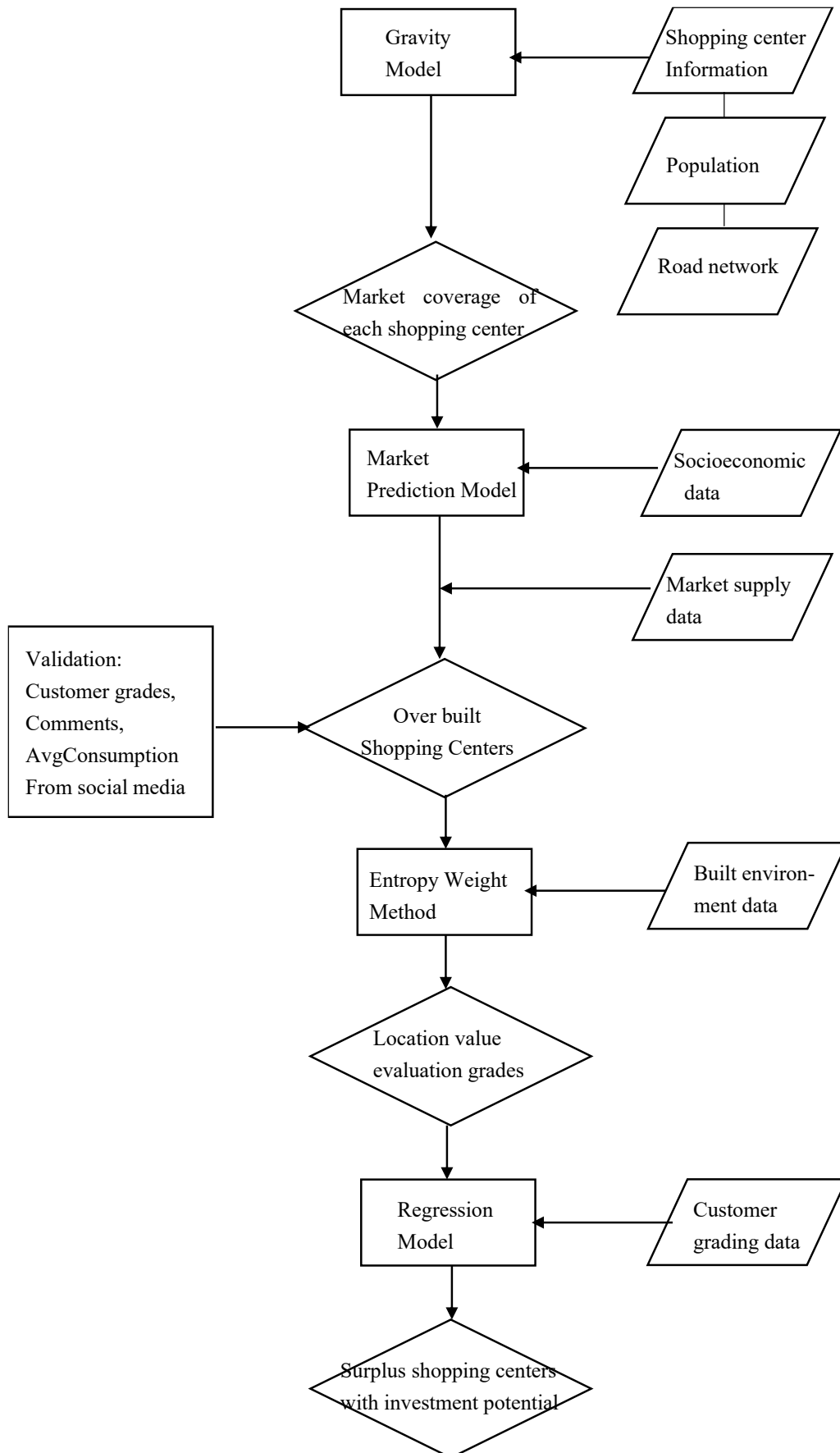
Data

Table 1. Data resources and types

Categories	Resources	Columns	Type
Shopping centers	Wrangled from Yingshang.com	building_area	float
		rentable_area	float
		built_year	integer
	Baidu Map API	coordinate	geometry
Socioeconomics	Chinese socioeconomical year book of 2020	population	integer
		population density	float
		disposable_income	integer
Social Media	Dianping.com	consumption expense	integer
		customer_gradings	integer
		road	geometry
Urban environment	Purchased from third party	parks	geometry
		subway_station	geometry
		POIs	geometry
		building_outlines	geometry

Methods

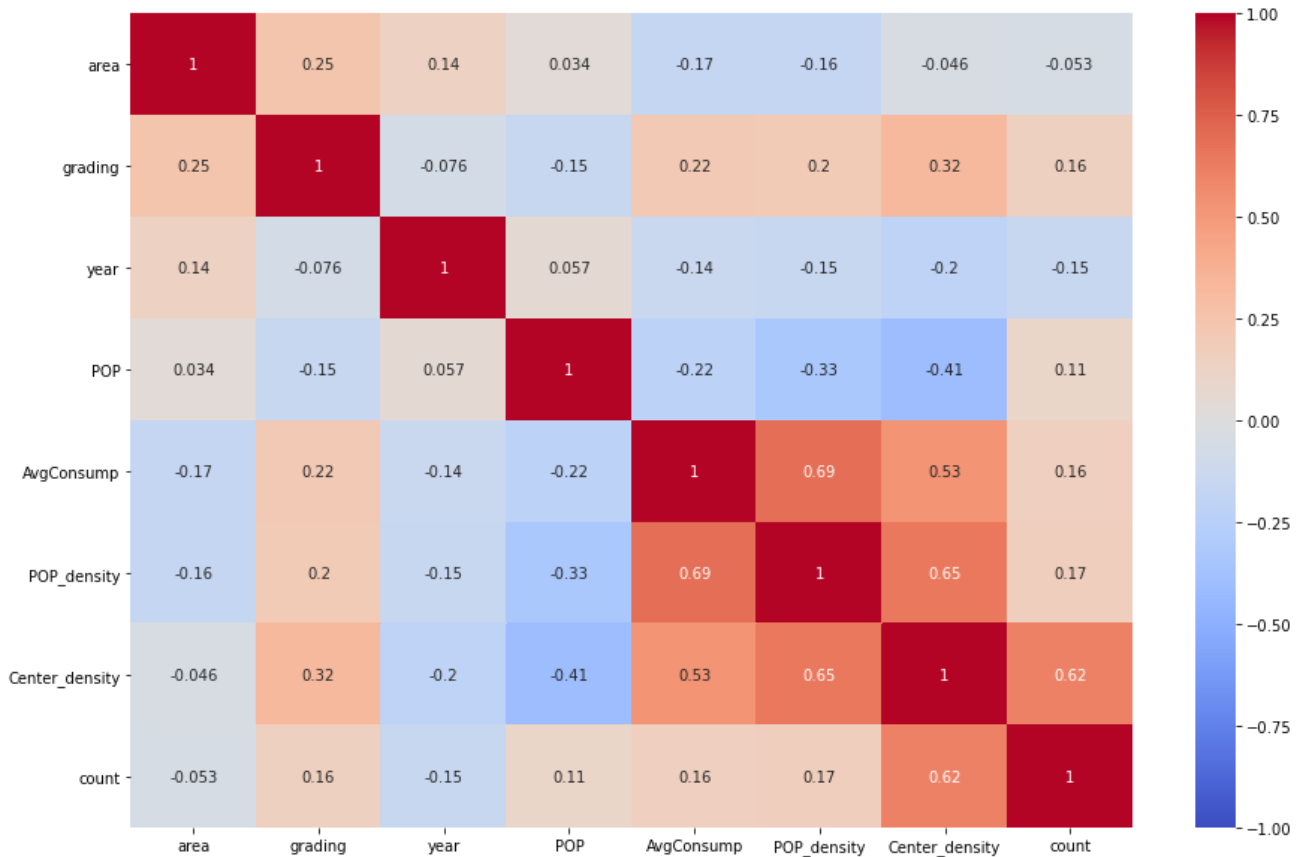
Fig 3. Workflow



The regression model demonstrates correlation between location value grades(X) and customer gradings(Y). Normally, there is positive correlation between two variables. Outliers beneath the regression line are regards as surplus shopping centers with investment or regeneration potential. If there is no significant correlation between two variables in the result, alternative methods will be applied.

Technical Implementation

Correlation Matrix



Customer gradings is correlated with AvgConsumption, population density, shopping center density and area. These features can be considered when optimizing

Gravity model

The gravity model of international trade states that the volume of trade between two countries is proportional to their economic mass and a measure of their relative trade frictions. In this research , gravity model is used to calculate the potential number of customers in each neighborhood

$$P_{ij} = \frac{W_i / D_{ij}^{\alpha}}{\sum_{i=1}^n \left(W_i / D_{ij}^{\alpha} \right)}$$

- P_{ij} = the probability of consumer j shopping at store i.
- W_i = a measure of the attractiveness of each store or site i.
- D_{ij} = the distance from consumer j to store or site i.

Table 2. Customer attraction matrix calculated by Gravity Model

	1	10	100	101	102	104	105	106	107	108	...	93	94	95	96	97
0	0.001741	0.000152	0.000580	0.001578	0.004740	0.003061	0.000196	0.001601	0.015114	0.006493	...	0.000623	0.005329	0.003351	0.002660	0.002303
1	0.001761	0.000157	0.000597	0.001542	0.004887	0.003114	0.000203	0.001729	0.010063	0.006131	...	0.000623	0.005482	0.003378	0.002697	0.002285
2	0.001002	0.000065	0.000298	0.002049	0.002515	0.001983	0.000095	0.000426	0.000705	0.029481	...	0.000518	0.002707	0.002420	0.001757	0.002317
3	0.001527	0.000129	0.000496	0.001464	0.004037	0.002662	0.000166	0.001272	0.026363	0.006388	...	0.000557	0.004555	0.002957	0.002327	0.002085
4	0.001128	0.000089	0.000367	0.001402	0.003102	0.002153	0.000125	0.000774	0.015585	0.007256	...	0.000483	0.003354	0.002479	0.001908	0.001869
5	0.001081	0.000068	0.000315	0.003505	0.002893	0.002159	0.000113	0.000421	0.000518	0.055122	...	0.000727	0.002863	0.003234	0.002280	0.002715
6	0.000562	0.000046	0.000192	0.000641	0.001636	0.001085	0.000067	0.000448	0.202322	0.002845	...	0.000237	0.001756	0.001244	0.000972	0.000874
7	0.000541	0.000039	0.000173	0.000755	0.001462	0.001055	0.000057	0.000314	0.001833	0.004872	...	0.000241	0.001579	0.001206	0.000913	0.000997
8	0.001935	0.000135	0.000574	0.002055	0.004850	0.003710	0.000179	0.000922	0.001823	0.022705	...	0.000773	0.005226	0.003800	0.002817	0.004014
9	0.001616	0.000146	0.000554	0.001371	0.004534	0.002858	0.000189	0.001669	0.004567	0.005319	...	0.000564	0.005094	0.003076	0.002467	0.002057

Supply & demand estimation model

$$S=N*I*R$$

- N = count of customers in market area(based on gravity model matrix)
- I = average consumption expense
- R = market penetration rate

$$D_{\min}=A*S$$

- A = rentable area
- S= minimum sales income per sqm to pay off the building and operation fees within 40 years mortgage(assuming 10,000 RMB/sqm/year)

Table 3. Result of shopping center supply-demand estimation

nickna	name	supply	demand	potenInco	surplus_Y
1	上海百联南方购物中心二区	1085457487	448000000	637457487	0
2	上海中信泰富广场	266766305	207000000	59766304.8	0
3	上海陆悦坊	82616874.2	60000000	22616874.2	0
4	上海松江印象城	1465379494	930000000	535379494	0
5	上海普陀绿地缤纷城	456635331	342000000	114635331	0
6	上海嘉杰国际广场	220672487	138000000	82672486.9	0
7	上海爱琴海购物公园	5780317709	1.44E+09	4340317709	0
8	上海仲盛世界商城	2687101224	1.752E+09	935101224	0
9	上海百盛(淮海店)	335408567	168000000	167408567	0
10	上海万科2049城花	47756208.4	42000000	5756208.4	0
11	上海百联世纪购物中心	964301768	384000000	580301768	0
12	上海绿色米兰奥特莱斯	374802478	270000000	104802478	0
13	上海崧泽华城生活汇	145566384	270000000	-124433616	1
14	上海久金广场	350334845	300000000	50334844.9	0
15	上海淮海南丰荟	131020891	79200000	51820891.1	0
16	上海君欣时代广场	576755080	240000000	336755080	0
17	上海港城新天地	300202793	300000000	202792.859	0
18	上海ist艾尚天地	361443916	156000000	205443916	0
19	上海汇宝购物广场	215362816	180000000	35362815.9	0
20	上海前滩太古里	1407382440	720000000	687382440	0
21	上海绿茵商业广场	190404587	258000000	-67595413	1

Validation

1) Significancy test

The average customer grades of identified malls is 3.83. 68 samples are randomly subset from dataset and calculate the average of customers grades. Repeat it for 100 times. All of the result is higher than 4.0, which validate the significancy of model.

2) Accuracy test

Comparing the 68 identified malls and 68 malls with lowest customer gradings, the accuracy is 81.1%

Result Exploration

Fig 4. Characteristic of identified surplus malls (red point)

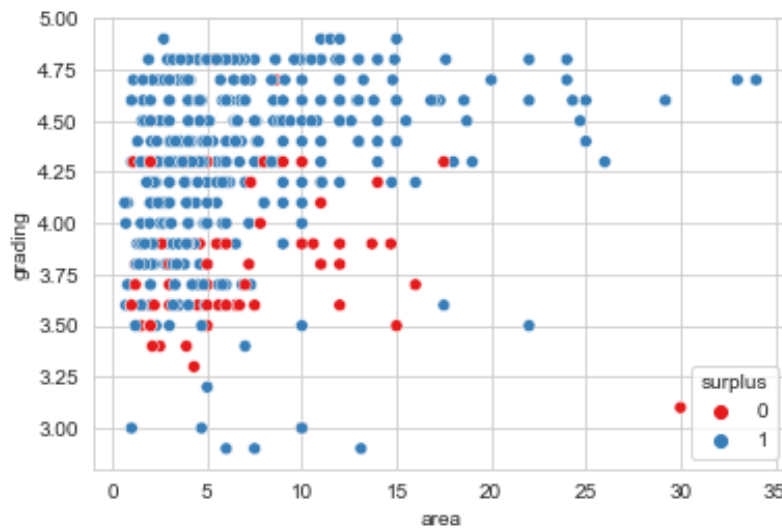
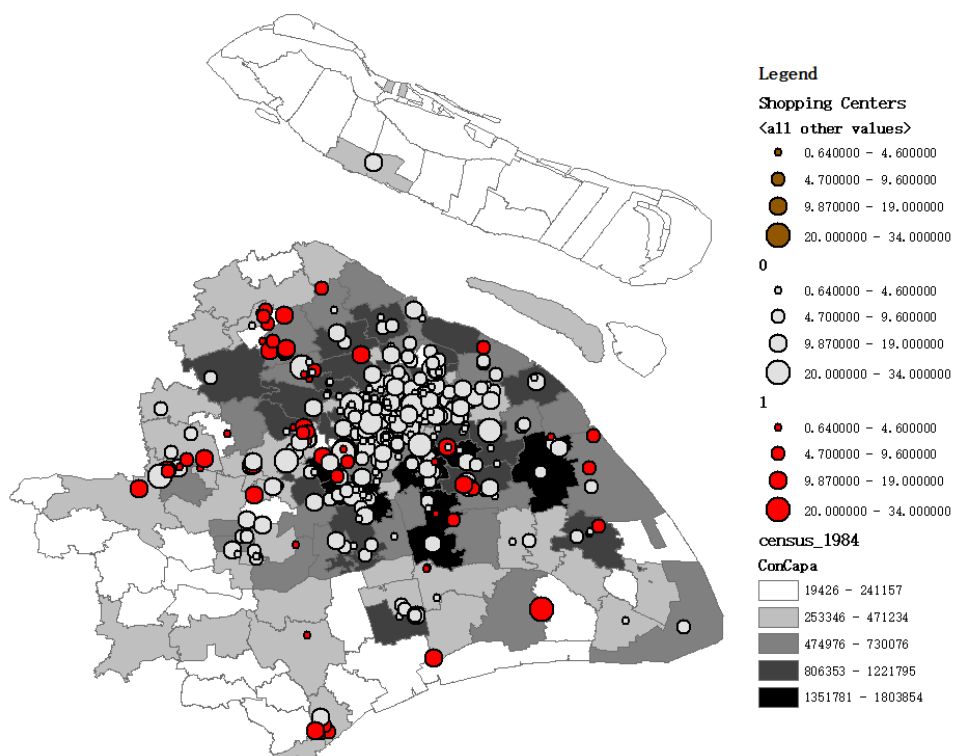


Fig 5. Spatial distribution of surplus malls (red point for surplus)



With current model, 68 out of 419 shopping centers are identified as surplus property which accounts for 15% of total area. Seeing from the Fig 4. low graded and median-scale malls are identified.

From the perspective of spatial distribution, most of surplus malls locate at suburban area where the total consumption capacity is small. Some surplus malls located at urban center periphery where the market is competitive.

Next Steps

- Try to adjust parameters of gravity model and compare the results.
- Add more dimensions into the validation process, considering number of comments and customer consumption from Dianping.com.

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