Analysis of Commercial Block Vitality Based on POI Density Data: A Case Study of Suzhou Shilu Commercial District

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Abstract. The vitality of traditional commercial districts is a critical indicator of urban quality in the context of stock renewal. This study investigates the attraction attenuation mechanism of the Shilu Commercial District in Suzhou using Point of Interest (POI) density data and Baidu heat maps. A diagnostic framework was constructed to analyze format supply characteristics and spatial vitality. The findings reveal a core-edge structure where the edge area is dominated by low-end shopping and accommodation formats, resulting in a "low-level equilibrium" characterized by functional homogeneity, limited vitality spillover, and weak linkage with surrounding attractions. This mechanism leads to behaviors such as "passing without entering" and reduced willingness to stay. The study proposes optimization strategies, including format upgrading, spatial activation, and full-time operation, emphasizing a shift from quantitative density to qualitative diversity. The research supplements existing diversity theory by introducing the concept of "diversity quality" and validates the applicability of the SOR (Stimulus-Organism-Response) model in diagnosing commercial district decline. The findings offer a practical framework for the refined renewal of similar traditional commercial districts.

Keywords: POI density data analysis, commercial block vitality, Suzhou Shilu Commercial District

1. Introduction

China's urban development has shifted from incremental expansion to stock improvement, making commercial block vitality a core indicator of urban quality [1]. Traditional commercial districts, carrying urban memory, face challenges from new commercial complexes and ecommerce. Big data, especially POI data with precise spatial positioning and format classification, provide a quantitative basis for vitality studies [2].

Suzhou's Shilu Commercial District, with a centuryold history, is one of the three major traditional municipal districts. Recently, emerging commercial centers like Suzhou Center have challenged its status: Shilu International Mall has declined due to outdated formats, and no new large complex has opened. Shilu is gradually becoming a regional district. Successful cases like Suzhou Ligongdi show that refined renewal is needed to stimulate vitality while preserving historical fabric.

This study focuses on the attraction attenuation mechanism of traditional commercial districts using POI density. It aims to construct a diagnostic framework, reveal the formation mechanism of Shilu's imbalanced format structure, and propose optimization strategies for Shilu and similar districts.

2. Literature review

2.1. Research progress on commercial block vitality

Foreign research on commercial block vitality began with Jacobs [3] , who emphasized functional diversity and mixed use, and Gehl [4] , who highlighted public space quality. Domestic studies using big data [5,6]have identified functional density, mix, and morphological compactness as key factors. Further studies [1,7] noted pedestrian space proportion, street facility richness, and interface permeability as critical.

2.2. Application of POI data in urban research

POI data are widely used in urban research [2]; common indicators include kernel density and Shannon entropy. In Suzhou, some studies [8] combined space syntax with POI data to study vitality, and Xiao et al. [2] found that physical environment, service formats, and place atmosphere jointly affect vitality.

2.3. Theoretical framework and research methods

The SOR model [9] explains how POI density and spatial environment influence consumer behavior; space syntax theory [10] uses integration and intelligibility to quantify accessibility, while Lynch's urban image theory [11] addresses block identifiability.

3. Research design

3.1. Research object and technical route

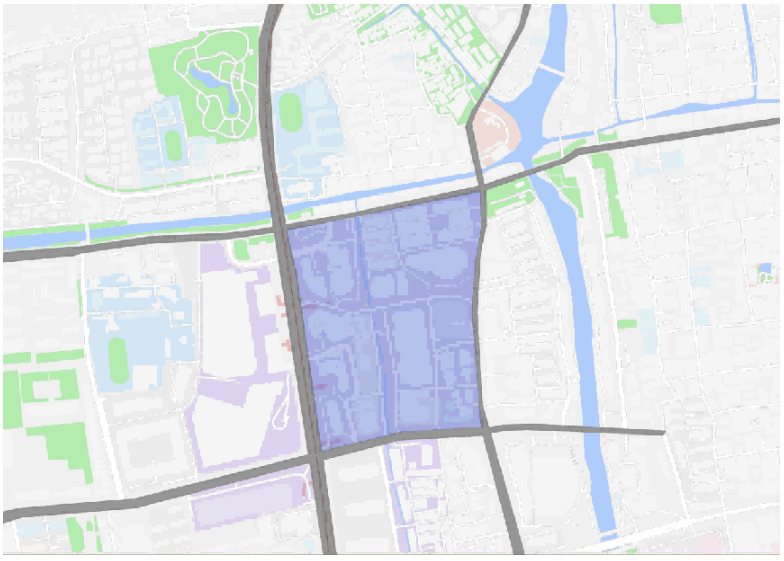

Figure 1. Research scope map

The study area is Suzhou Shilu Commercial District (approx. 55.11 ha), with its core Shilu Pedestrian Street (0.127 km²) [12]. It has a centuryold commercial history, a radial road network, and high building density. Recently, it has faced declining vitality and is now a key urban renewal area.

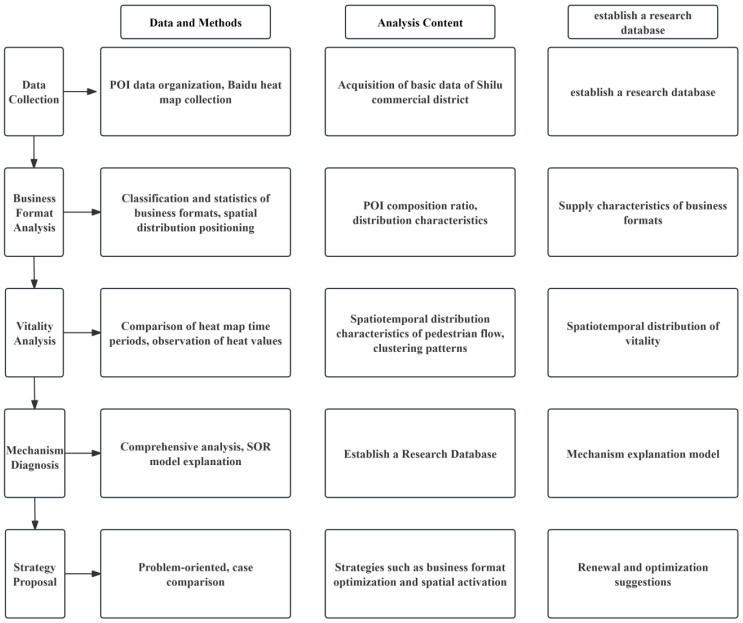

Figure 2. Technical route diagram

The technical route comprises four steps: (1) collect and clean POI data of Shilu, conduct kernel density analysis and format classification statistics; (2) collect Baidu heat map data, analyze pedestrian flow agglomeration at different times on weekdays and weekends; (3) based on data analysis, diagnose the attraction attenuation mechanism and propose optimization strategies.

3.2. Data sources and processing

Two data sources:

POI data: 23 valid samples from AutoNavi Maps API, classified into six categories (catering, shopping, cultural and sports entertainment, life services, accommodation, science and education).

Table 1. Classification statistics of POI sample data

Major Category	Quantity	Percentage (%)
Shopping	9	39.1
Accommodation	6	26.1
Life Services	4	17.4
Catering	2	8.7
Science and Education	1	4.3
Cultural and Sports Entertainment	1	4.3
Total	23	100.0

Vitality data: Heat data were collected from Baidu heat maps for two consecutive weeks in October 2025 (including weekdays and weekends), at six time periods daily (8:00, 11:00, 14:00, 17:00, 20:00, 22:00). The relative concentration of pedestrian flow is reflected by the depth of the heat map color. Note that heat maps reflect the relative density of mobile phone users and cannot accurately distinguish between "passing by" and "staying" [2].

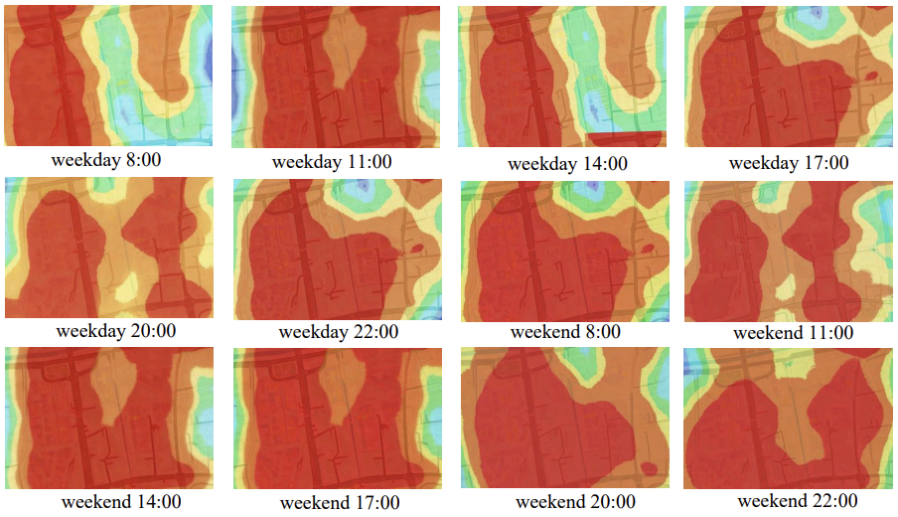

Figure 3. Baidu heat mapexample(part)

3.3. Indicator system

Table 2. Vitality evaluation indicator system

Dimension	Indicator	Calculation Method	Data Source
Functional Density	POI Point Distribution	Spatial positioning and distribution characteristics of points	POI Data
Functional Density	Proportion of Various POIs	Quantity of each POI type / Total POI quantity × 100%	POI Data
Spatial Vitality	Heat Value Distribution	Comparative observation of heat maps across time periods	Baidu Heat Map
Spatial Vitality	Vitality Agglomeration Characteristics	Observation of high heat value area distribution	Baidu Heat Map

4. Case analysis

4.1. Analysis of format supply characteristics

4.1.1. POI spatial distribution characteristics

The 23 POI samples are mainly concentrated in Baochengqiao Street, Taohuaqiao Road, and Taohuawu Avenue on the northeastern edge, about 500 m from the core. They are linearly distributed, forming a communityservice functional belt.

Table 3. Regional distribution statistics of POI sanples

Distribution Area	Quantity	Percentage (%)	Main Formats
Baochengqiao Street Area	12	52.2	Shopping, Accommodation, Catering
Taohuaqiao Road Area	6	26.1	Shopping, Accommodation, Life Services
Changmen Heng Street/Xizhongshi Area	3	13.0	Accommodation, Life Services
Taohuawu Avenue	2	8.7	Catering, Shopping
Total	23	100.0	

This distribution characteristic reflects that the edge area of the Shilu Commercial District is dominated by community service functions, with commercial facilities linearly arranged along the main streets, not yet forming planar agglomeration. Compared with the core area of Shilu Pedestrian Street, the commercial density and level of this area are significantly lower, lacking large commercial nodes, making it difficult to form secondary vitality centers [13].

4.1.2. Format composition characteristics

Figure 4. (a): Shilu formats (1) - communtiy convenience STOREstore andother shopping formats

Figure 4. (b): Shilu formats (2) - Shomestays and other accommodation formats

Sample formats: shopping (39.1%, mostly community convenience stores), accommodation (26.1%, homestays near Shantang but lacking business linkage [14]), life services (17.4%), catering (8.7%), science/education (4.3%), cultural/sports (4.3%). No chain or characteristic brands, indicating low commercial level.

4.2. Analysis of spatial vitality characteristics

Baochengqiao Street area maintained low-medium heat all day, indicating insufficient commercial density to attract pedestrian flow [15]; few spontaneous stays reflect poor public space quality [10].

Table 4. Heat observation at different times on shilu commercial district(weekday vs weekend)

Time	Weekday Heat	Weekend Heat	Main Distribution Area	Pedestrian Flow Characteristic
8:00	Low	Low	Surrounding Subway Stations	Commuter flow / Morning exercise, breakfast
11:00	Medium-Low	Medium	Catering Areas / Core	Start of lunch consumption / Pre-noon rising
14:00	Low	Medium-High	Scattered in Core / Core & MixC World	Afternoon trough / Afternoon peak (leisure)
17:00	Medium	Medium-High	Pedestrian Street Core, Subway / Core & secondary nodes	Evening commute, consumption begins / Peak continues
20:00	Medium-High	Medium	Pedestrian Street Core, commercial nodes / Core, catering areas	Peak of leisure consumption / Evening decline
22:00	Medium-Low	Medium-Low	Catering night markets, Subway / Catering night markets, Subway	Night consumption declines / Night consumption ends

4.3. Diagnosis of the attraction attenuation mechanism

Attraction attenuation mechanisms: (1) format homogenization [14] → goal-oriented consumption; (2) aging spatial environment [1] → reduced willingness to stay; (3) insufficient Shantang linkage [9] → tourist flow not channeled; (4) barriers to emerging formats [2]→ limited appeal to youth. Recent mall renovations are positive but need continuous effort.

5. Discussion of results

5.1. A supplement to Jacobs' diversity theory

Shilu's edge area supplements Jacobs' diversity theory: diversity requires not only type richness but also functional correlation and level matching [3]. The area's "low-level diversity" [13]—formats present but unconnected—cannot generate vitality. Thus, we propose "diversity quality", emphasizing high-value format proportion and correlation [8].

5.2. Applicability explanation of the SOR model

Applying the SOR model [9]: low-end POIs, poor environment, and weak connections (S) lead to tourists perceiving "nothing to browse" and residents "basic needs only" (O), resulting in "pass without entering" and purposeful consumption (R). This highlights "stimulus quality" as a key moderating variable.

5.3. The formation mechanism of "low-level equilibrium"

The "low-level equilibrium" forms through four phases [16,15]: initial homestay/community agglomeration → replication of low-end commerce, lock-in → limited core spillover, Shantang flow not channeled → prolonged low vitality deters investment, reinforcing equilibrium.

6. Optimization strategies

6.1. Format optimization: transition from "quantity" to "quality"

Shift from density to quality [14]: leverage homestays to extend catering/leisure ("accommodation + light catering + cultural experience"); implant cultural shops/cafes as nodes; develop nighttime eateries/pubs; upgrade convenience stores with fresh food.

6.2. Spatial activation: from "passing through" to "staying"

Improve staying quality [1]: open pedestrian connection to Shantang with signage/shops/rest nodes; create Ring River waterfront walkway; renovate sidewalks/facades, improve night lighting [1]; form "touring in Shantang, shopping in Shilu, staying in Baocheng" circulation [9].

6.3. Full-time operation: from "daytime" to "all day"

Cultivate full-time operation [6]: extend evening peak with "day coffee, night alcohol", night markets, performances; guide Shantang tourists to Shilu core (afternoon) and Baocheng (evening) for full consumption chain; Baocheng develop "homestay + late-night eatery". Full-time operation requires format mix—catering alone insufficient [4].

6.4. Normalization of data diagnosis

Incorporate data diagnosis [2]: POI dynamic monitoring, health assessment indicators, data-based project prioritization. Use Shilu Revitalization Alliance for data sharing and multi-governance, including edge merchants to coordinate core-edge development.

7. Conclusion and prospect

7.1. Main conclusions

Main conclusions: (1) core-edge structure with edge dominated by low-end shopping (39.1%) and accommodation (26.1%), lacking catering/entertainment, homestays not converted to consumption; (2) vitality concentrated in core, edge low-medium heat all day, limited radiation; (3) edge "low-level equilibrium" [15]—low-end lock-in, poor linkage with core/Shantang, poor environment, causing "passing without entering" and "buy then leave".

7.2. Research limitations

Limitations (small POI sample, qualitative heat maps, single case) suggest future research: expand POI collection, integrate multi-source data [2], conduct comparative studies [16], and track Shilu renewal to evaluate core-edge linkage.

7.3. Subsequent prospects

Subsequent research can be deepened in the following directions: expand the scope of POI data collection to obtain more complete format data for the Shilu Commercial District; introduce multi-source data fusion such as consumption data and mobile signaling data to more accurately measure consumption behavior and stay duration [2]; extend to other traditional commercial districts such as

Guanqian Street and Nanmen Commercial District for comparative studies to verify the generalizability of the relevant mechanisms [16]; conduct long-term tracking of the renewal projects in the Shilu Commercial District to evaluate the implementation effect of the core-edge linkage strategy.

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