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Reimagining Urban Streets as Vibrant Fourth Places

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Abstract. This study explores the potential of urban streets to function as "fourth places," characterized by hybridity, openness, and fluid social interactions. Although streets are transitional, little research has focused on streets since the concept of the fourth place has been applied to various spaces. To address this gap, the study develops a Fourth Place Index (FPI) based on behavioral observations of 20 streets in Beijing, capturing indicators such as stationary individuals, interaction, and micro-space utilization. The FPI is further analyzed through machine learning methods to find out the environmental factors that shape the sense of place of streets. Results show that building interface openness, seating availability, and accessibility are the most influential factors. Besides, by extending the fourth place framework to streets, these findings contributed to theory and offered a quantitative method for evaluating pedestrians' social functions, and provide practical guidance for urban design and planning. The study highlights the importance of designing "semi-open" and interactive pedestrian spaces to enhance inclusiveness and vitality in modern urban spaces.

Keywords: Urban streets, Fourth place, Sense of place, Behavioral observation, Urban design

1. Introduction

As an important part of the daily lives of residents, streets provide a space where they can socialize, exercise, and engage in other daily activities [1]. In recent years, driven by the rapid development of urbanization in China, the function of streets has been transforming from a single traffic corridor to a complex space that integrates social, recreational, and work functions. Therefore, the transition of streets from neutral spaces to meaningful places has become a topic of concern. As Balasubramanian stated, as one common open space in a city, streets do not only assume a traffic function that connects urban environmental elements together; it also "serves as a place" for social interactions, community engagements, and daily activities [2].

In recent years, the concept of the "fourth place" has been proposed to capture transitional and connective urban spaces that differ from home, workplace, and traditional gathering venues [3]. Although the concept has been applied to a range of hybrid environments, little attention has been given to streets.

Therefore, this study aims to fill this gap by conceptualizing streets as a typical form of the fourth place and by proposing a framework to measure their social qualities. Based on behavioral observations of twenty streets in Beijing, a Fourth Place Index (FPI) is established to capture key

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aspects of interaction, lingering, and micro-space utilization. Furthermore, the study investigates how specific environmental features influence the FPI, offering insights into the design elements that most effectively enhance the social role of streets.

2. Concept & background

2.1. Theoretical framework

Place Theory is an important theoretical framework in Human Geography and Environmental Psychology. It stresses that we should not simply regard space as “a neutral container” [4]. Specifically, space acquires meaning through human perception, lived experience and social practices, thereby being transformed into “place”, as Yi-Fu Tuan puts it “what begins as undifferentiated space becomes place as we get to know it better and endow it with value” [5].

In 2016, Patricia, an urban planning scholar formally proposed the concept of the “fourth place” [3]. Unlike the concept of “third place”, which refers to public gathering places outside of home and work, such as cafes, bars, barbershops, libraries, etc., and these spaces are characterized by neutrality, inclusivity, and low barriers to entry [6-8]. The “fourth place” focuses on the interactions among strangers in other public places that the spatial conditions that facilitate these encounters differ from formal, defined urban public spaces. In fact, the “fourth place” occupy transitional, threshold, or connective spaces as they are characterized by "in-betweenness" [3]. Alternatively, “the fourth place” is a unique fusion of the "first place," "second place," and "third place" [9].

2.2. Street as the fourth place

Streets are actually interfaces between "internal order" and "external order", they serve both as physical corridors and stages for the performance of social relationships [10]. This differs streets from the first place (e.g. home) and the second place (e.g. workplace) which exhibit strong functional singularity, and also distinguishes streets from the third place which emphasizes stable social interactions. Simultaneously, it also positioned streets as a hybrid space that mixed the other types of places.

Therefore, the features of the street lie in its transitional and open qualities, that is to say, "in-betweenness". To be more particular, social interactions on the street are often temporary, fluid, and diverse, and with the development of digital technologies, streets developed further hybrid features like food delivery or on-demand logistics. Finally, such features justified the recognition of the street as a typical fourth place within the urban context.

2.3. Literature review

A study conducted in 2021 indicated that the sense of place could be evaluated from two dimensions of “place level” and “place equity”, the former includes intensity of use and sense of belonging and the latter includes spatial allocation and perceived fairness [11]. Another study also indicated that successful placemaking involves key attributes like accessibility, legibility, vitality, diversity, and comfort [12]. These articles provide various practical methods to quantify the sense of place.

Currently, academic research on “the fourth place” mainly focuses on some specific public hybrid spaces. Researchers indicated that subway as a “fourth place”, it facilitates "a passive form of social contact" through specific spatial norms and bodily behaviors [13]. Some researchers explored new church models through the concept of the “fourth place”, emphasizing that churches should function not merely as isolated sanctuaries but as integral parts of the community, effectuating tangible

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influence among people [14]. Furthermore, a study focused on the post-pandemic period, proposing three types of "fourth places", including coliving apartments (коливинг), coworking spaces (коворкинг), and anti-cafes (антикафе) [15]. The author also indicated that the prevalence and conceptual development of the "fourth place" have been relatively delayed in the post-pandemic era.

However, researchers have yet to examine urban streets from the perspective of "the fourth place". This study therefore seeks to fill this gap by conceptualizing the street as a fourth place and tries to propose some optimization strategies.

3. Methodology

3.1. Behavioral observation

Behavioural observation has been proven effective in previous studies on spatial cognition [16]. With 20 urban streets in Beijing as the research subjects, this study will employ a structured behavioural observation method to conduct field investigations. Each observation targets a 100-meter road segment, with an observation duration of 15 minutes. The 20 streets were labelled as Street A to Street T to protect the identity of locations.

3.2. Behavioral observation

First, the author recorded basic information about street characteristics, including Road type, Observation Segment Length, Total Street Width, Sidewalk Width, Pedestrian-vehicle Separation and Sidewalk Continuity.

Second, the key information regarding environmental features is also recorded, including Observation Time, Shade Facilities, Seating/Rest Facilities, Accessibility, Crossing Facilities, Noise Level, Sense of Safety, and Visual Diversity.

Third, this study conducted observations on human activities. The following indicators were measured: Total Pedestrian Count, Cyclist Count, Stationary Individuals, Pedestrian Interaction Frequency, Pedestrian Interaction Events, Micro-Space Utilization, Temporary Activity Count, and Building Interface Openness.

Detailed information about the indicators is presented in the following Table 1.

Table 1. Indicators of street characteristics, environmental features, and human activities

Category	Indicator	Description
Street Characteristics	Road type	Classification of the road as arterial road, secondary road, or residential street
	Observation Segment Length	Length of the observed street segment (measured in meters via satellite maps)
	Total Street Width	Total width of the street (including carriageway, sidewalks, and medians), measured in meters
	Sidewalk Width	Width of the sidewalk, classified by taking the integer part after dividing the actual width by 2
	Pedestrian-vehicle Separation	Degree of separation: 0 = fully separated, 1 = partially separated, 2 = no separation
	Sidewalk Continuity	Uninterruptedness of the sidewalk, quantified by counting the number of breakpoints

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Table 1. (continued)

Environmental Features	Observation Time	Observation period: midday (12:00–17:00) or evening rush hour (17:00–21:00)
	Shade Facilities	Proportion of shaded area: 1 = <25%, 2 = 25%–75%, 3 = >75%
	Seating/Rest Facilities	Total count of seating and rest facilities available on the sidewalk
	Accessibility	Number of crossing facilities (max score = 3; score = 4 for fully open streets)
	Crossing Facilities	Type and count of pedestrian crossing facilities (e.g., zebra crossings, overpasses, underpasses)
	Noise Level	Sound intensity measured at the segment, in decibels (dB)
	Sense of Safety	Perceived safety (incremented by 1 for each: lighting, security personnel, traffic order, safety facilities)
	Visual Diversity	Variety of visual elements, categorized as low, medium, or high
Human Activities	Total Pedestrian Count	Total number of pedestrians observed at the segment during the observation period
	Stationary Individuals	Number of people observed staying in a fixed location (not moving)
	Pedestrian Interaction Frequency	Total count of interactions between pedestrians during the observation period
	Pedestrian Interaction Events	Types of interactions (asking for directions, conversations, assistance, consumption, work, performances, vending, sports)
	Micro-Space Utilization	Frequency of micro-space usage (e.g., rider rest stops, courier parking, corner seating) per 10 min per 100 m
	Temporary Activity Count	Number of temporary activities (e.g., stalls, performances, mobile vendors) per 100 m
	Building Interface Openness	Openness degree of facades: 1 = closed walls, 2 = scattered entrances, 3 = continuous small shops, 4 = open transparent interfaces

4. Analysis

4.1. Fourth Place Index (FPI)

Previous studies have found that the social characteristics and opportunities to make social interaction provided by the place are the most significant factors affecting the sense of place [17]. What's more, researchers have also pointed out that "place dependence," namely the functional attachment to a place, is another important factor influencing the sense of place [18]. Therefore, drawing on the above findings, this study incorporates the fluidity, "in-betweenness", and hybridity of the "fourth place" into consideration, using behaviors like pedestrian interaction, lingering, and utilization of micro-spaces as the main representations of the "fourth place" in urban streets.

In order to measure the sense of place of streets as the fourth places, this study establishes a Fourth Place Index model (FPI). The FPI is composed of the following four categories of indicators:

Stay Rate (S)

$$S = \frac{Stationary\ Individuals}{Total\ pedestrian\ count} \tag{1}$$

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Interaction Rate (I)

$$I = \frac{Pedestrian\ Interaction\ Frequency}{Total\ pedestrian\ count} \tag{2}$$

Micro-space Utilization Rate (M)

$$M = \frac{Micro\ Space\ Utilization}{Total\ pedestrian\ count} \tag{3}$$

Event Diversity (D)

$$D = \frac{Number\ of\ distinct\ interaction\ event\ types}{Maximum\ preset\ types} \tag{4}$$

Then, this study adopts Principal Component Analysis [19], which is a multivariate statistical technique commonly used to analyze observational data described by multiple correlated quantitative variables [20]. In practice, PCA first standardizes the data (S , I , M and D) , obtaining standardized data ($\widetilde{S}, \widetilde{I}, \widetilde{D}, \widetilde{M}$). Finally, to ensure positive FPI values, this study scales the data to the range [0.1, 5.0]. Overall, FPI is computed using PCA as follows:

$$X_i = w_s \bullet \widetilde{S}_i + w_I \bullet \widetilde{I}_i + w_D \bullet \widetilde{D}_i + w_M \bullet \widetilde{M}_i \tag{5}$$

$$FPI_i = 0.1 + \frac{X_i - min(X)}{\max(X) - \min(X)} \times (5.0 - 0.1) \tag{6}$$

Where i denotes the i -th street, w_S, w_I, w_M, $and\ w_D$ are the PCA weights for S, I, $M\ and\ D$ respectively.

Based on the behavioral data collected in this study, the Fourth Place Index (FPI) was calculated for 20 streets in Beijing. The resulting FPI values are presented in the following Table2 and Table3.

Table 2. Fourth Place Index (FPI) for streets A–J

Street	A	B	C	D	E	F	G	H	I	J
FPI	2.26	2.49	3.15	1.07	3.25	2.82	2.43	3.29	0.10	2.01

Note. After calculation, $w_s \approx 0.534$, $w_D \approx 0.546$, $w_M \approx 0.406$, $w_D \approx 0.502$.

Table 3. FPI for streets K–T

Street	K	L	M	N	O	P	Q	R	S	T
FPI	1.96	1.48	2.75	2.23	1.79	4.08	1.69	1.47	5.00	1.25

Note. After calculation, $w_s \approx 0.534$, $w_D \approx 0.546$, $w_M \approx 0.406$, $w_D \approx 0.502$.

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4.2. Environmental determinants of FPI

4.2.1. Model construction

In this part, this study will examine the impact of environmental factors on FPI to explore a better street design paradigm. In previous investigations, this study recorded the following design indicators: Shade Facilities, Seating/Rest Facilities, Accessibility, Crossing Facilities, Noise Level, Sense of Safety, Building Interface Openness, Total Street Width, Sidewalk Width, Sidewalk Continuity and Visual Diversity. It should be noted that most of the data in this study are categorical data, which may lead to the issue of having few independent variables. Additionally, due to small sample size, there may also be a problem of overfitting.

Therefore, the author notes that previous research which analysed 420 independent variable dimensions with only 25 samples used Random Forest (RF) method and proposed an improved analytical approach [21]. By using this improved approach, this study uses street environmental indicators as independent variables and FPI as the dependent variable for analysis. Lasso (Least Absolute Shrinkage and Selection Operator) method (LassoCV with 5-fold cross-validation) was applied to select features, employing L1 regularization to filter the most relevant features from high-dimensional data while preventing overfitting [22]. The objective function of Lasso is as follows:

$$\min_{\beta} \left(\sum_{i=1}^{n} \left(y_i - \widehat{y_i} \right)^2 + \lambda \sum_{j=1}^{p} |\beta_j| \right) \tag{7}$$

After selecting features, a Random Forest regression model was built using the selected features. five-fold cross-validation was employed to evaluate model performance, reporting predicted values, mean squared error (MSE), and coefficient of determination (R^2) for each fold. After training, final predictions were generated using the full dataset. This study evaluated our RF model by comparing predicted FPI with FPI using $R^2, RMSE \, and \, MAE$. Based on the data from this study, the evaluation results after calculation are as follows:

$$R^2 \left(coefficient \, of \, determination \right) \approx 0.902 \tag{8}$$

$$RMSE \left(root \, mean \, squared \, error \right) \approx 0.338 \tag{9}$$

$$MAE \left(mean \, absolute \, error \right) \approx 0.276 \tag{10}$$

Overall, this study consider the Random Forest model provides accurate and reliable predictions of FPI.

4.2.2. Key environmental factors

The Lasso method extracted seven of the most predictive indicators from 13 independent variables. After RF analysis, their feature importance (relative contribution to explaining FPI variance, with higher values indicating greater influence on model predictions) is as follows Table 4:

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Table 4. Random forest feature importance

Feature	Importance
Building Interface Openness	0.333
Seating Count	0.156
Accessibility	0.152
Total Street Width	0.126
Crossing Open	0.097
Noise Level	0.074
Ped Vehicle Separation	0.062

Furthermore, to quantify the contribution of each feature to the RF predictions, this study used SHAP (SHapley Additive exPlanations), which is proven effective for enhancing the interpretability of RF models [23]. For a model f and a feature set $x = (x_1, x_2, \ldots, x_M)$, the SHAP value ϕ_j for feature j is defined as follows:

$$\phi_j = \sum_{S \subseteq F \setminus \{j\}} \frac{|S|!(M-|S|-1)!}{M!} \left[f_{S \cup \{j\}} \left(x_{S \cup \{j\}} \right) - f_S \left(x_S \right) \right] \tag{11}$$

Where F is the set of all features, S is a subset of features excluding j, $f_S(x_S)$ is the model prediction using only features in S.

A positive ϕ_j indicates that the feature increases the prediction, while a negative ϕ_j indicates a decreasing effect, in this study, the direction of SHAP values could be observed in the following Figure 1. The SHAP value of the data in this study are presented in the Table 5 below:

Table 5. SHAP feature importance for street attributes

Feature	Mean |SHAP value|	Mean SHAP value
Building Interface Openness	0.445	0.035
Seating Count	0.214	0.012
Accessibility	0.175	-0.013
Crossing Open	0.127	0.002
Total Street Width	0.091	0.009
Ped Vehicle Separation	0.060	0.008
Noise Level	0.034	0.015

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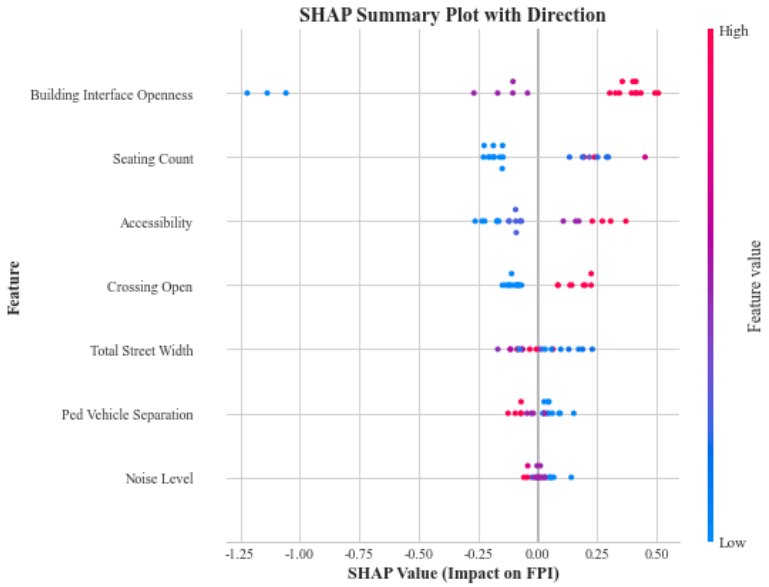

Figure 1. SHAP summary plot with direction

Note. Each point represents a street sample

Finally, this study applied Partial Dependence Plots [24] to visualize how the predicted outcome changes as a specific feature varies, while averaging out the effects of all other features. Mathematically, the partial dependence of a feature X_s is defined as:

$$\widehat{f_s}(x_s) = \frac{1}{n}\sum_{i=1}^{n}\widehat{f}(x_s, x_{iC}) \tag{12}$$

Where $\widehat{f_s}(x_s)$ is the trained model prediction function and x_{iC} denotes the other features of the i -th observation. This study chose the top three indicators influencing FPI after Lasso analysis. Their PDPs could be seen in Figure 2.

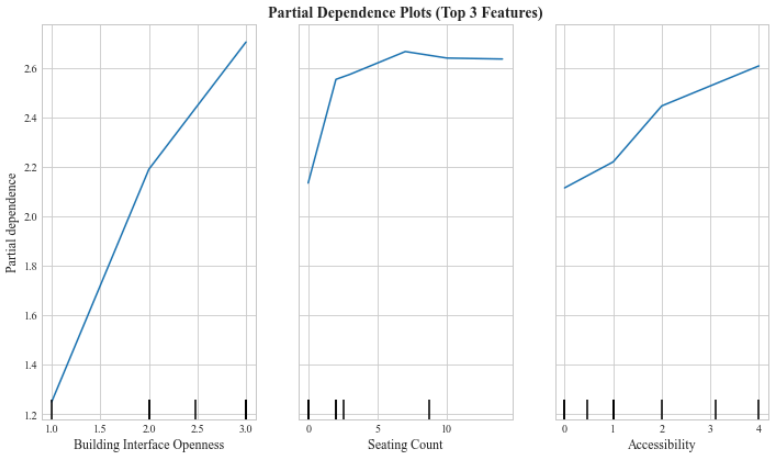

Figure 2. Partial dependence plots (top 3 features)

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5. Conclusion

Urban streets are typical “fourth places” due to its inherent mixed-use nature, interactivity and “in betweenness”. This study first quantitatively evaluated the fourth place attribute of 20 streets in Beijing using indicators of behavioural observation on pedestrians, establishing a Fourth Place Index (FPI). Then this study developed a Random Forest (RF) model to predict FPI based on the recorded environmental factors, and analysed the extent to which these factors contribute to the construction of streets as the "fourth place".

Feature importance analysis revealed that Building Interface Openness was the most influential variable, followed by Seating Count and Accessibility. The ranking from SHAP analysis corroborated these findings, providing additional interpretability. Therefore, this study drew the conclusion that the creation of open and pedestrian-friendly spaces is the primary factor that enables streets to possess the characteristics of a typical "fourth place". Similarly, this study also found that broader street spaces and well-designed pedestrian-vehicle separation facilities are also positive to the sense of place in streets.

In summary, this study attempts to propose a type of "semi-open" pedestrian space, a design that on one hand ensures the safety of pedestrian spaces through well-equipped safety facilities, and on the other hand guarantees the accessibility of pedestrian spaces and their interactivity with building interfaces. In this way, as a type of "fourth place", streets can maximize their function in urban spaces and build their sense of place by facilitating interactions among pedestrians and encouraging more diverse behaviors, enhancing the inclusiveness and friendliness of cities.

However, this study still has several limitations. Due to the constraints of a limited sample size and the lack of repeated observations the stability of model cannot be fully guaranteed. Although this study adopted a variety of techniques in order to maximize the exploration of independent variable dimensions under the condition of a limited sample, insufficient data volume may still lead to deficiencies in the model’s generalization ability. Second, the environmental indicators selected in this study are relatively limited. Owing to these limitations, the data in this study could not fully and effectively fit the complexity of FPI using the OLS (Ordinary Least Squares) method. Therefore, we cannot rule out the possibility that the sense of place of streets is influenced by more unobserved factors, which also suggests that future studies need to further verify and expand the conclusions of this study under the conditions of larger-scale data with more diverse dimensions.

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