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The Impact of Street Elements on Pedestrian Stopping Behavior in Commercial Pedestrian Streets from the Perspective of Commercial Vitality

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Abstract: As urban design increasingly emphasizes livable environments, research on pedestrians and walking environments has been revisited at the street level. Although existing studies have shown that street environments impact pedestrians, there remains a significant gap in our knowledge regarding which street elements affect pedestrian walking behavior, to what degree, and which walking characteristics are influenced. This study aims to validate the close relationship between street elements and pedestrian stopping behavior by measuring the influence of different street element environments on walking characteristics. Research methods include a literature review and field research, categorizing street elements into 32 types and pedestrian stopping behaviors into 10 characteristics. By collecting effective walking data from 1587 pedestrians and conducting data processing and regression analysis, we found that rational street design can effectively promote commercial activity and enhance street vitality. Based on the experimental conclusions, we propose urban design recommendations to further enhance the vitality of commercial pedestrian streets, including optimizing street landscape design, improving pedestrian facilities, and increasing leisure spaces. This research provides valuable references for further exploring how to enhance the vitality of commercial pedestrian streets, helping urban planners and designers better understand the relationship between street elements and urban vitality, thereby creating more attractive and vibrant urban spaces and promoting sustainable urban development.

Keywords: street elements; commercial pedestrian street; stopping behavior; urban design

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1. Introduction

Jane Jacobs, in her seminal work *The Death and Life of Great American Cities*, posited that interaction and engagement are the hallmarks of urban life. She argued that successful urban planning must incorporate these social dynamics, as plans that overlook urban vitality actually hasten urban decline and impoverishment [1]. Jacobs placed great importance on the function of pedestrian streets, viewing them as fundamental units for evaluating urban spaces and environments. Pedestrian spaces, she asserted, are the most vital places for city dwellers.

Colin Buchanan, in his seminal work "*Traffic in Towns*", emphasized that pedestrian-friendly streets can effectively reflect the value of life and society. Designing streets to be people-oriented and pedestrian-friendly can directly enhance the quality of life for residents [2]. Michael Southworth and Ivan Ben-Joseph have proposed focusing on pedestrian-centric design, providing spaces for interaction and relaxation, and building a community centered around streets for living and shared use [3].

The design and planning of pedestrian commercial streets are crucial for commercial prosperity and directly impact residents' quality of life and the sustainable development of cities. With the acceleration of urbanization, the need for well-designed pedestrian commercial streets has become increasingly prominent. Therefore, it is of significant practical importance to study the relationship between the elements of pedestrian street interfaces and pedestrian stopping behavior.

Plato suggested that expansion stems from the competition for limited resources [4]. In early urban design, streets were primarily designed to serve motor vehicle traffic, which marginalized the status of pedestrians in urban spaces and reduced their opportunities for interaction and participation [5]. The transformation of such negative street environments also feeds back into pedestrians' psychological perceptions. Streets that were once vibrant and bustling have become increasingly desolate, further diminishing their appeal and creating a vicious cycle that leads to the decline of the streets [6]. Against this backdrop, the importance of human-centered design has been reemphasized, with a growing number of scholars and planners advocating for the reassessment of pedestrian attributes in street design. Research on different types of streets has shown that various elements such as the functional nature of streets [7], spatial organization [8], street landscape [9], street scale [10], and street amenities [11] all have an impact on the overall vitality of the streets.

The positive effects of walking on urban vitality have been repeatedly confirmed, and designs, including pedestrian commercial streets, are shifting back towards pedestrian-friendly approaches.

In daily life, it is evident that different street interface designs evoke different feelings; well-designed streets encourage people to stay, and pedestrian presence, in turn, enhances street vitality and promotes its improvement, creating a positive feedback loop. Understanding how these street interface elements influence people and the specific impacts they have is a key research question.

In this study, we will explore the mechanisms through which various street elements in pedestrian commercial streets affect pedestrian stopping behavior. We will examine the influence of different elements on pedestrian activities, analyzing dimensions such as storefront design, street width, and public service facilities. The goal is to provide new insights and methods for the development and planning of urban commercial pedestrian streets, offering references for designing more vibrant pedestrian commercial streets.

1.1. Street Elements and Pedestrian Stopping Behavior

The vitality of urban street spaces is closely linked to street interface elements. Yoshinobu Ashihara, in *The Aesthetic Townscape*, considers continuous street interfaces, formed by building facades and their attachments, as the premise for creating street spaces [12]. These building facades, attachments, and various other elements not only form a tightly connected physical interface but also play a crucial role in human perception, directly and indirectly influencing pedestrian behavior. Kevin Lynch's research indicates that individuals discern the overall environment of a place by relying on different sensory experiences provided by the surrounding elements. They extract paths, edges, districts, nodes, and landmarks from the impressions in their minds, forming the five elements of a cognitive map to create a behavioral map [13].

Street interface elements also affect pedestrians' perception and evaluation of the surrounding environment. Schulz's study has validated that streets, serving as a distinctive organizational pattern within the urban spatial framework, play a crucial role in shaping the emotional experiences of residents. Furthermore, it has extracted a range of elements from spatial environments that can exert either positive or negative influences on people [14]. Attractive, clean, and vibrant street interfaces leave a positive impression, draw pedestrians' attention, and enhance their sense of identification and satisfaction with the area, thus promoting pedestrian stopping behavior. Therefore, improving the vitality of street spaces requires enhancing street interface elements through thoughtful design and layout, creating environments that attract people and stimulate their desire to stay, thereby promoting pedestrian stopping behavior.

1.2. Pedestrian Stopping and Commercial Street Vitality

A study by Jan Gehl's team tracked and analyzed the use of urban public spaces and pedestrian stopping behavior, categorizing human activities into necessary activities, spontaneous activities, and social activities. In commercial street settings, pedestrian stopping activities are significantly more frequent on active and vibrant commercial streets compared to passive ones. Additionally, the variety of stopping activities on active streets is greater, ranging from simple observation and rest to interactive communication. This improvement in spatial quality profoundly impacts pedestrian willingness to walk and increases pedestrian stopping activities [15]. Thoughtfully arranged street elements can guide pedestrian movement, enhance the walking experience, and make distances seem shorter. They also improve pedestrians' enjoyment of observing and interacting with their surroundings [16]. The interplay between the external characteristic elements and the internal components of the commercial district can also influence the vitality of the commercial area's spatial dynamics [17].

Street stopping activities carry complex social attributes, reflecting the appeal of the street space itself as a destination [18]. For a city to be truly dynamic, it needs captivating urban spaces that engage and connect with its populace. Numerous cases illustrate that the combination of dense buildings and low-level urban spaces does not aid in boosting urban vitality and cannot inspire interest among people [16]. Improving the street environment not only increases the proportion of pedestrian stops but also extends the duration of these stops, further boosting the overall commercial vitality of the street and promoting pedestrian interaction and engagement [19]. Streets, as important urban spaces, must be designed to meet human activity needs first and foremost, with a special emphasis on improving the vibrancy and appeal of the street environment [20].

1.3. Objective Representation and Measurement Dimensions of Pedestrian Stopping Behavior

Pedestrian stopping activities on streets reflect the street space's attractiveness to pedestrians. Objective representation and measurement dimensions of stopping behavior serve as crucial bases for evaluating and analyzing pedestrian stopping behavior, helping researchers systematically understand and quantify pedestrian staying behavior in urban street spaces. In this study, we analyze pedestrian stopping behavior and identify key factors for quantification. In subsequent recordings, we will discuss pedestrian stopping behavior through multiple measurement dimensions covering stop frequency, duration, reasons, and other factors.

1.4. Research Objectives

This research will be based on the viewpoint of commercial vibrancy to investigate the relationship between different street elements and the walking and stopping behavior of pedestrians. Our research focuses on the following questions:

1. Do pedestrian walking characteristics influence the commercial vitality of streets?
2. Do street elements affect pedestrian stopping behavior?
3. From the perspective of urban design, how can the environmental friendliness and habitability of city streets be improved through the design of these street elements?

In addressing the aforementioned issues, this paper will investigate the collective influence of diverse street interface elements on pedestrian stopping behavior, further uncovering the connectivity and significance of these elements within street design on the behavior of pedestrians who stop. The goal is to offer design principles for the creation of more dynamic urban street environments. Moreover, by analyzing the characteristics of pedestrians' walking and stopping, this research will develop a more holistic set of evaluation metrics for street interface elements. It will examine how different street elements affect the everyday walking activities of pedestrians to enhance the reference indicators for street design. This study will also take into account the relationship with urban design, delving deeper into the impact of streets on the psychological and physiological indicators of pedestrians.

2. Materials and Methods

2.1. Research Location

This study focuses on Central Street in Harbin as the research site. Located at the heart of Harbin, Central Street was established in 1898, extending approximately 1450 m and covering an area of about 1 square kilometer. It is China's first commercial pedestrian street and features a variety of architectural styles, including Renaissance, Eclecticism, Art Nouveau, Classicism, and Modernism.

Central Street in Harbin encompasses numerous historic preservation buildings and a rich array of modern commercial elements. The street is continuous and spacious, with a comprehensive and diverse array of storefronts and abundant street interface elements such as squares and sculptures. The high pedestrian flow, which includes all typical characteristics of a commercial pedestrian street, makes it an ideal research site. Additionally, the various nodes along the street, each with unique features, provide a representative and rich sample for collecting pedestrian activity data (Figure 1).

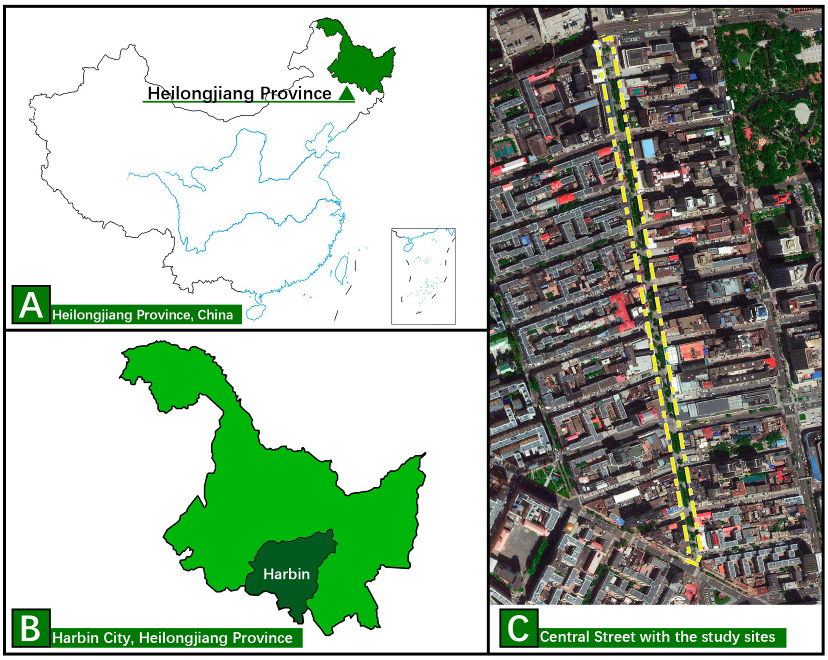

Figure 1. Map of the experimental location. (**A**) Heilongjiang Province, China; (**B**) Harbin City, Heilongjiang Province; (**C**) Central Street with the study sites.

2.2. Selection and Classification of Street Elements

Christian Norberg-Schulz posits that the cross-section of a street forms the fundamental unit of a landscape scene, making the elements present in this cross-section the most direct influences on pedestrian activities [14]. By observing the spatial and interface characteristics of a street's cross-section, these street elements can be broadly classified into three categories:

1. Public Street Elements: This includes various street furniture and public elements such as the density of benches, sculptures, etc.
2. Building Interface Elements: This encompasses buildings and their façade elements, including storefront density and the transparency of the commercial storefront façade.
3. Spatial Perception Elements: This category includes spatial scale and pedestrian perception elements such as the street's width-to-height ratio and pedestrian flow.

Among the elements to be studied, some have been less frequently researched and others lack quantitative descriptions. Therefore, in this study, we will attempt to comprehensively cover various street elements and conduct a quantitative analysis to build a rich and complete evaluation system for commercial pedestrian street elements. This approach will facilitate a more thorough analysis of the relationship between street elements and pedestrian activities and allow for more rational recommendations for street design (Figure 2).

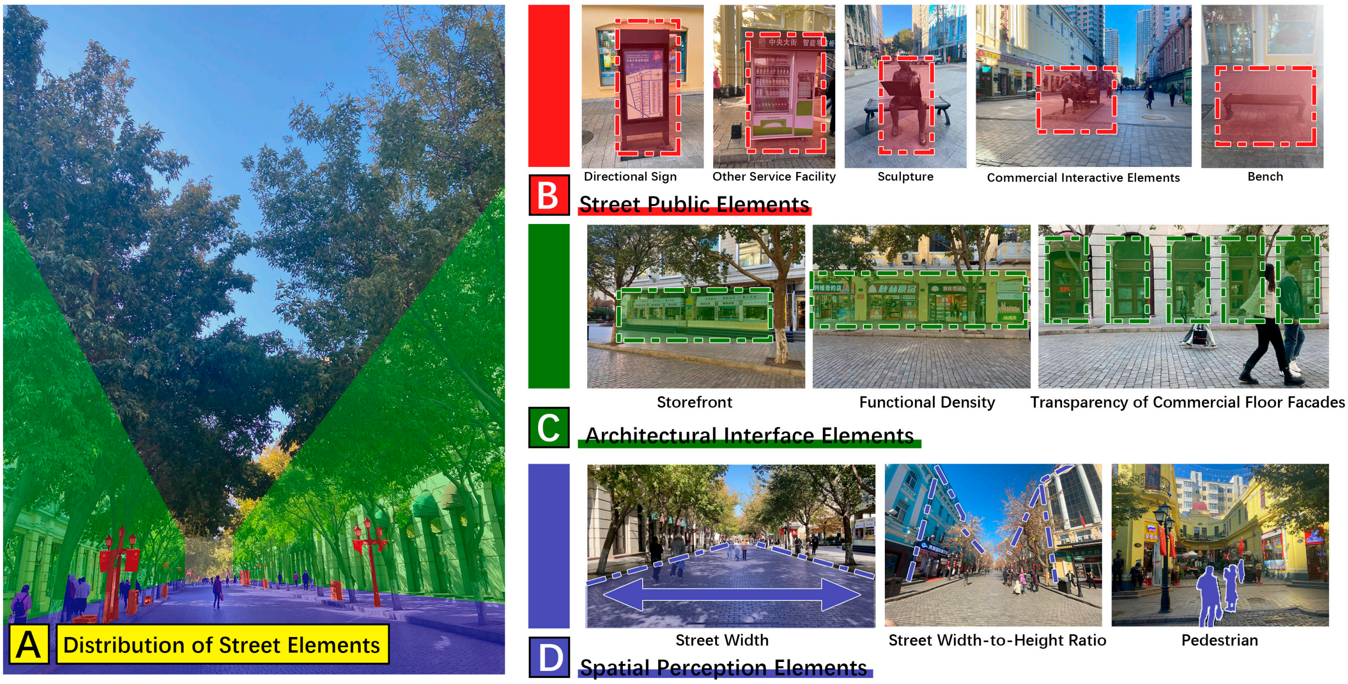

Figure 2. Classification of Street Elements: (**A**) Distribution of Street Elements; (**B**) Public Street Elements; (**C**) Building Interface Elements; (**D**) Spatial Perception Elements.

2.2.1. Public Street Elements

From the perspective of functionality, public street elements can be divided into two categories: public service elements aimed at providing basic services and pedestrian interaction elements aimed at promoting pedestrian activity.

X_1 Density of Public Service Elements: The density of public service elements in the target street segment that are aimed at providing basic services. These elements include a variety of items such as benches, flower beds, sanitation facilities, and directional signs.

X_{1-1} Bench Density: Benches are divided into formal and auxiliary benches. Formal benches include standard long benches, while auxiliary benches are facilities suitable for temporary rest, such as platforms or stone blocks of appropriate height and size. When calculating the total length of benches, different coefficients are assigned to different benches based on their actual usage.

X_{1-2} Flower Bed Density: Plants can stimulate people's intention to participate in street activities, enhance the attractiveness of the street, and enrich the pedestrian experience [21]. Reasonable spatial arrangement and matching of plants can form new connections and expand their impact range [22].

X_{1-3} Sanitation Facility Density: Abundant sanitation facilities objectively contribute to street cleanliness and enhance the pedestrian experience.

X_{1-4} Directional Sign Density: Includes facilities such as commercial maps and signage.

X_{1-5} Other Service Facility Density: Includes other types of public service facilities such as vending machines and shared power banks.

X_2 Density of Pedestrian Interaction Elements: The density of pedestrian interaction elements aimed at promoting pedestrian activity within the target street segment. These elements can be roughly divided into four categories: recessed areas, sculptures, interactive animals, and commercial interactive facilities.

X_{2-1} Recessed areas: Recessed areas (e.g., shaded areas, small semi-enclosed plazas) in commercial pedestrian streets help aggregate commercial elements. Recessed areas are among the most attractive urban spaces, and even those formed unintentionally through planning can have a significant multiplier effect, not only gathering pedestrians but also enhancing their satisfaction [23]. Recessed areas can simultaneously meet a variety of needs and facilitate quick transitions between activities, efficiently concentrating human activities in this manner while also making the street space more open and vibrant [24].

X_{2-2} Sculpture Density: Sculptures are an important part of pedestrian streets, reflecting urban culture and often incorporating commercial elements, effectively enhancing the street's commercial vitality.

X_{2-3} Interactive Animals: Animal activities are a unique means of enhancing the attractiveness of public spaces, particularly for specific groups. Recent research on outdoor therapeutic environments indicates that small animals that can interact with people can significantly extend outdoor stay times [25].

X_{2-4} Density of Commercial Interactive Elements: Non-commercial facilities that can interact with pedestrians, such as store mascots. The shift in consumption patterns demands that shopping activities provide memorable experiences rather than just selling products [26]. Good consumer experiences during shopping can enhance purchase desires, and some commercial interactive elements can effectively boost commercial vitality.

2.2.2. Building Interface Elements

In a well-designed street, active ground-level interfaces need to support public activities on the street, reflected in aspects such as storefront density, functional density, and transparency [27].

X_3 Transparency of Commercial Floor Facades: Refers to the transparency of the building interface on both sides of the street at the commercial floor level. Based on the degree of spatial permeability, storefronts are classified into fully open storefronts (Type 1); transparent glass windows allowing direct visibility into the interior (Type 2); display windows with merchandise setups (Type 3); and opaque solid walls blocking interior views (Type 4). The calculation method is the ratio of the horizontally penetrable building interface length to the total length of the street-facing building interface in each segment [28].

X_4 Density of Commercial Display Elements: Includes signage and neon signs that attract attention to the ground-level building interface. According to Yoshinobu Ashihara, display elements such as signage on buildings form the "second skyline" of architecture, stimulating pedestrians' visual aesthetics [12].

X_5 Functional Density: Refers to the variety of functional businesses in each street segment, categorized into 11 types: retail food, dining, street snacks, clothing, luxury goods, daily necessities, cultural entertainment, hotels, financial services, electronics, and offices [27].

X_6 Storefront Density: The density of land use and building density around the street affects walking attractiveness and quality, influencing pedestrian activities [29].

2.2.3. Spatial Perception Elements

Pedestrians are influenced by perception elements in different street environments, forming subjective impressions of the street space. Scholars have summarized several spatial perception elements that are relatively impactful on pedestrians, with key elements selected for discussion in this study.

X_7 Pedestrian Flow: The number of people on the street affects the perception of the street environment. In relatively crowded public spaces, pedestrians tend to develop social tendencies for emotional exchange with the crowd, being attracted by other people and activities, which induces active stays [30].

X_8 Visible Street Greenery Index: The proportion of green plants within the pedestrian's field of vision. Compared to traditional green coverage, the visible street greenery index emphasizes three-dimensional visual effects, representing a higher level of greening [31,32]. Generally, a higher visible street greenery index in pedestrian environments correlates with greater perceived environmental charm and better spatial quality [21].

X_9 Street Width-to-Height Ratio: The ratio of street width to the average height of buildings on both sides. This ratio intuitively reflects the openness of the street space. For commercial streets, a width-to-height ratio (D/H) between 1:1 and 1:2 creates an active and effective space conducive to a comfortable atmosphere [12].

X_{10} Storefront Width-to-Street Width Ratio: When the ratio of storefront width to street width (W/D) is $\leq$1, it forms a lively atmosphere, enhancing street vitality [12].

X_{11} Street Width: The overall width of the pedestrian area within the street and the average distance between the building facades of the commercial floors on both sides.

X_{12} Street Elevation Difference: The difference in elevation between the two parts of the pedestrian path in a cross-section of the street, which are typically connected by steps or curbstones. The platform and steps formed by the elevation difference between the interior and exterior of buildings do not count as a pedestrian path elevation difference.

X_{13} Spatial Openness: Refers to the openness of exterior space, with quantitative indicators including visual gaps, distance to obstructions, height, and visual weight. The enclosure of the street facade plays a crucial role in the formation of street space. The degree of openness of street spaces of different scales has an intuitive impact on people's psychological perceptions [33].

X_{14} Interface Density: The ratio of the projected width of buildings on both sides of the street to twice the length of the street, indicating the degree of street enclosure. Generally speaking, excessively high interface density can affect street openness, making the street space feel closed and oppressive, which is not conducive to creating a comfortable street environment [34]. An interface density of 0 indicates no buildings on either side, while 1 indicates completely continuous buildings on both sides [35].

2.2.4. Classification and Statistical Table of Street Elements (Independent Variables)

Based on the aforementioned content, the elements are filtered and categorized as follows (Tables 1 and 2):

Table 1. Street Element Classification.

Level 1	Level 2	Level 3
Street-Related Element	**Evaluation Factors**	**Evaluation Indicators**
Public Street Elements	Public Service Elements	X_1 Density of Public Service Elements
		X_{1-1} Bench Density
		X_{1-2} Flower Bed Density
		X_{1-3} Sanitation Facility Density
		X_{1-4} Directional Sign Density
		X_{1-5} Other Service Facility Density
	Pedestrian Interaction Elements	X_2 Density of Pedestrian Interaction Elements
		X_{2-1} Open Street Space Density
		X_{2-2} Sculpture Density
		X_{2-3} Interactive Animal Density
		X_{2-4} Commercial Interactive Element Density

Table 1. *Cont.*

Level 1	Level 2	Level 3
Street-Related Element	**Evaluation Factors**	**Evaluation Indicators**
Building Interface Elements	X_3 Transparency of Commercial Floor Facades	
	X_4 Density of Commercial Display Elements	
	X_5 Functional Density	
	Commercial Storefronts	X_6 Storefront Density
		X_{6-1} Food Storefront Density
		X_{6-2} Restaurant Storefront Density
		X_{6-3} Street Snack Storefront Density
		X_{6-4} Clothing Storefront Density
		X_{6-5} Luxury Goods Storefront Density
		X_{6-6} Daily Necessities Storefront Density
		X_{6-7} Cultural Entertainment Storefront Density
		X_{6-8} Hotel Density
		X_{6-9} Financial Bank Storefront Density
Spatial Perception Elements	X_7 Pedestrian Flow	
	X_8 Visible Street Greenery Index	
	X_9 Street Width-to-Height Ratio	
	X_{10} Storefront Width-to-Street Width Ratio	
	X_{11} Street Width	
	X_{12} Street Elevation Difference	
	X_{13} Spatial Openness	
	X_{14} Interface Density	

Table 2. Classification and Quantification of Street Elements (Independent Variables).

Code	Street Elements	Quantitative Description/Calculation Formula
X_1	Public Service Elements Density	Number of Public Service Elements/Total Length of Street Segment × 100
X_{1-1}	Bench Density	(Length of Basic Benches × 1 + Length of First Type Auxiliary Benches × 0.5 + Length of Second Type Auxiliary Benches × 0.25)/Total Length of Street Segment × 100
X_{1-2}	Flower Bed Density	Total Length of Flower Beds/Total Length of Street Segment × 100
X_{1-3}	Sanitation Facility Density	Number of Sanitation Facilities/Total Length of Street Segment × 100
X_{1-4}	Directional Sign Density	Number of Directional Signs/Total Length of Street Segment × 100
X_{1-5}	Other Service Facility Density	Number of Other Public Service Facilities/Total Length of Street Segment × 100
X_2	Pedestrian Interaction Elements Density	Number of Pedestrian Interaction Elements/Total Length of Street Segment × 100
X_{2-1}	Recessed Areas Density	Number of Recessed Areas/Total Length of Street Segment × 100
X_{2-2}	Sculpture Density	Number of Sculptures/Total Length of Street Segment × 100
X_{2-3}	Interactive Animal Density	Number of Interactive Animal Areas/Total Length of Street Segment × 100
X_{2-4}	Commercial Interactive Element Density	Number of Commercial Interactive Elements/Total Length of Street Segment × 100
X_3	Transparency of Commercial Floor Facades	(Length of Type 1 Interface × 1.25 + Length of Type 2 Interface + Length of Type 3 Interface × 0.75)/Total Length of Street Segment's Building Interface
X_4	Density of Commercial Display Elements	Length of Commercial Display Elements/Total Length of Street Segment × 100
X_5	Functional Density	Number of Functional Types/Total Length of Street Segment × 100
X_6	Storefront Density	Number of Storefronts/Total Length of Street Segment × 100

Table 2. *Cont.*

Code	Street Elements	Quantitative Description/Calculation Formula
X_{6-1}	Food Storefront Density	Number of Food Storefront/Total Length of Street Segment × 100
X_{6-2}	Restaurant Storefront Density	Number of Restaurant Storefronts/Total Length of Street Segment × 100
X_{6-3}	Street Snack Storefront Density	Number of Street Snack Storefronts/Total Length of Street Segment × 100
X_{6-4}	Clothing Storefront Density	Number of Clothing Storefronts/Total Length of Street Segment × 100
X_{6-5}	Luxury Goods Storefront Density	Number of Luxury Goods Storefronts/Total Length of Street Segment × 100
X_{6-6}	Daily Necessities Storefront Density	Number of Daily Necessities Storefronts/Total Length of Street Segment × 100
X_{6-7}	Cultural Entertainment Storefront Density	Number of Cultural Entertainment Storefronts/Total Length of Street Segment × 100
X_{6-8}	Hotel Density	Number of Hotels/Total Length of Street Segment × 100
X_{6-9}	Financial Bank Storefront Density	Number of Financial Bank Storefronts/Total Length of Street Segment × 100
X_7	Pedestrian Flow	Number of People Passing through a Section in 1 Minute/Width of Pedestrian Sidewalk at that Section
X_8	Visible Street Greenery Index	Green View Area in Street Cross-section/Total Street Cross-section Area
X_9	Street Width-to-Height Ratio	Street Width/Average Height of Buildings along the Street Segment
X_{10}	Storefront Width-to-Street Width Ratio	Average Width of Storefronts along the Street Segment/Street Width
X_{11}	Street Width	Pedestrian Area of the Street Segment/Total Length of Pedestrian Area
X_{12}	Street Elevation Difference	Elevation Difference of Pedestrian Sidewalks in the Street Segment
X_{13}	Spatial Openness	Angle of Open Interface/360°
X_{14}	Interface Density	Projected Length of Buildings along the Street Segment/Length of Street Segment

2.3. Selection and Classification of Pedestrian Walking and Stopping Behaviors

Pedestrian stopping activities on streets carry complex social and commercial attributes, reflecting the attractiveness of street spaces as destinations for pedestrians [36]. These behaviors indicate pedestrians' subjective evaluations of public landscape aesthetics, including the material landscape's attractiveness, spatial richness, and perceptual qualities. These evaluations quantify public opinion [37]. This study selects five pedestrian stopping behavior characteristics that are possibly related to street attractiveness and quantifies them to explore the impact of street elements on pedestrian stopping behaviors.

2.3.1. Definition of Pedestrian Stopping Intention

Jan Gehl posits that spontaneous stopping activities significantly enhance urban street vitality [19]. According to Gehl's views on spontaneous activities, specific activities on streets can be categorized into necessary, spontaneous, and social activities, with commercial and social activities being the primary sources of urban vitality. Spontaneous stopping behavior heavily depends on external environmental characteristics and is closely related to the spatial interface of streets [19]. Pedestrians' spontaneous stopping behavior reflects the influence of the surrounding environment on their psychology, directly indicating their willingness to stay. As a crucial dependent variable, willingness to stay quantifies pedestrians' inclination to stop.

2.3.2. Definition of Relative Stopping Time

When pedestrians are attracted by street elements, they may either stop to admire or slow down instead of halting. To include the latter behavior, this study introduces "relative stopping time", the difference between the actual time pedestrians take to traverse a section and the theoretical time required at a normal walking speed. Typically, East Asian pedestrians' average walking speed is about 1.22 m/s, with male pedestrians averaging 1.27 m/s and females 1.18 m/s. This study calculates the difference between each pedestrian's recorded time and theoretical time through a section, representing their relative stopping time. A positive value indicates attraction, zero suggests no influence, and a negative value implies a lack of attraction or even repulsion, indicating the segment's overall lack of appeal.

2.3.3. Definition of Average Walking Speed

Walking speed describes the distance a pedestrian covers per unit time, influenced by personal attributes (e.g., height and health) and environmental characteristics, reflecting the external walking environment's impact [38]. The average walking speed of pedestrians through a recorded area is considered a dependent variable, reflecting the street elements' potential impact. A lower walking speed suggests the street elements are attractive, while a higher speed indicates a lack of appeal.

2.3.4. Definition of Participation Tendency

In public spaces, people have a psychological desire for social interaction and are easily attracted to other people and activities [39]. The continuous occurrence of activities in a street's public space prompts broader and richer activities, exemplifying the "participation tendency" [30]. This study classifies pedestrian stopping behaviors based on their participation tendency towards street interface elements into five categories (Figure 3).

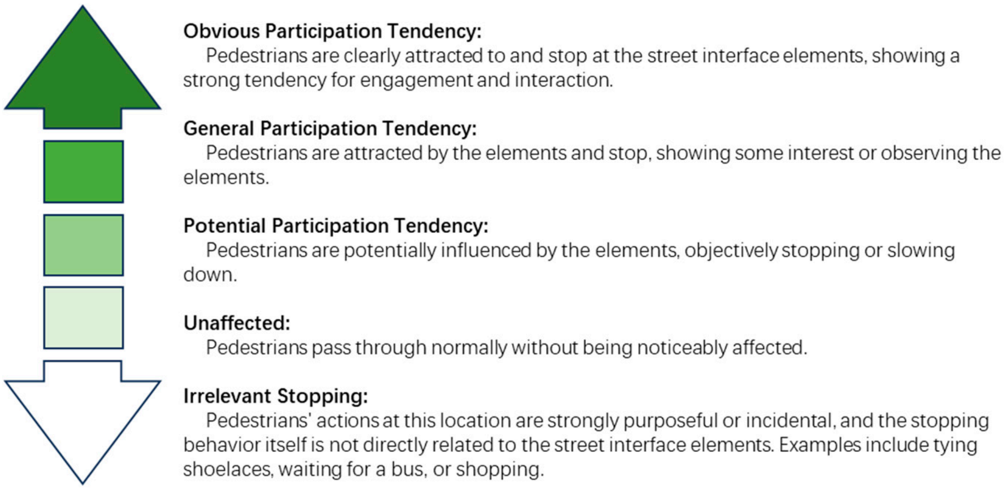

Figure 3. Classification of Pedestrian Stationary Behavior Participation.

According to Jan Gehl, the fifth category has a strong purpose and is pre-planned, not spontaneous, and thus excluded from this study.

2.3.5. Stopping Reasons

According to Jan Gehl, spontaneous commercial and social activities are fundamental reasons for creating urban vitality [19]. Based on this, pedestrian stopping behavior on streets can be categorized into two types according to the reasons for stopping: commercial stopping and social stopping. Commercial stopping refers to pedestrians being attracted by goods, commercial information, or commercial facilities, leading to behaviors such as lingering, staying, and observing. Social stopping refers to pedestrians stopping due to non-commercial factors, including appreciation, communication, and guidance.

2.3.6. Classification and Statistical Table of Pedestrian Walking and Stopping Behavior (Dependent Variables)

Based on the above content, the elements are filtered and classified, and pedestrian walking and stopping behavior (dependent variables) can be categorized as follows (Table 3).

Table 3. Classification and Quantification of Pedestrian Walking and Stationary Behavior (Dependent Variables).

Code	Pedestrian Walking and Stopping Behavior Characteristics	Quantitative Description/Calculation Formula
Y_1	Pedestrian Stopping Intention	0 = Not stopping, 1 = Stopping
Y_2	Relative Stopping Time	Relative stopping time = Actual passage time − Theoretical expected passage time
Y_3	Walking Average Speed	Walking average speed = 10 m/(Actual passage time − Stopping time)
Y_4	Participation Tendency	0: Not stopping. 1: Weak participation stopping. Such as standing still chatting, waiting for companions, noticeably slowing down, etc. 2: Moderate participation stopping. Such as admiring sculptures, watching shop window displays, etc. 3: Strong participation stopping. Such as taking photos with sculptures, feeding pigeons, etc.
Y_{4-1}	Weak Participation Stopping	0 = No weak participation stopping occurred, 1 = Weak participation stopping occurred or relative stopping time significantly prolonged
Y_{4-2}	Moderate Participation Stopping	0 = No moderate participation stopping occurred 1 = Moderate participation stopping occurred
Y_{4-3}	Strong Participation Stopping	0 = No strong participation stopping occurred 1 = Strong participation stopping occurred
Y_5	Stopping Reason	0 = Not stopping, 1 = Commercial stopping, 2 = Social stopping
Y_{5-1}	Commercial Stopping	0 = No commercial stopping occurred, 1 = Commercial stopping occurred
Y_{5-2}	Social Stopping	0 = No social stopping occurred, 1 = Social stopping occurred

2.4. Research Methodology

2.4.1. Measurement Objects

The survey was conducted on two working days with suitable temperatures and good weather conditions (23–24 October 2023). The survey time was set from 14:00 to 16:00 in the afternoon, during which pedestrian traffic is relatively stable and major meal and shopping periods are avoided. The proportion of pedestrians walking aimlessly is relatively high, which can comprehensively reflect the characteristics of pedestrian walking activities on most streets under general circumstances.

In this experiment, pedestrian walking characteristics are the focus, so pedestrian data that do not meet the requirements will be excluded in the subsequent data processing.

Subjectively, data of individuals who are not actively involved in walking will be excluded, such as security personnel, construction workers, infants, and toddlers.

According to the classification of pedestrian travel modes, non-walking behaviors will be excluded, such as wheelchairs, hoverboards, and skateboards.

According to the purpose of pedestrian stopping behavior, data with strong purposiveness or unexpectedness in pedestrian stopping behavior will be excluded, such as tying shoelaces, waiting for buses, etc.

In the actual statistical process, all walking characteristics of eligible pedestrians were recorded truthfully and comprehensively, covering various types of pedestrian groups to ensure the diversity and representativeness of the samples, thereby guaranteeing the accuracy and reliability of the research results.

2.4.2. Selection of Walking Spaces

The central street, designated as the sample, is divided based on the positions and characteristics of its various street segment nodes. After excluding segments affected by construction, eight representative typical commercial pedestrian street nodes were selected from the remaining segments. In order to comprehensively understand the influence of street elements on pedestrian stopping behavior in different environments, these eight nodes all have distinct characteristics and representativeness, covering different regions and common types of elements found in pedestrian streets. Observation points and monitoring equipment were set up at each measurement node to obtain the street interface elements of each node through on-site measurements, and the various elements were quantitatively processed according to the interface characteristics of their profiles.

2.4.3. Measurement Methods and Data Collection

Eight locations were selected as survey objects, and on-site survey data were recorded and some elements were quantified to obtain the interface variable values of the eight nodes. Segments with complex traffic situations, such as construction sections, entrances to large shopping malls, and road intersections, which are not conducive to recording pedestrian walking and stopping situations, were excluded. At each node, a segment of the road with a smooth surface, stable street element characteristics, and suitable for video recording, no less than 10 m in length, was selected. Video recording and snapshot methods were used to record the walking characteristics and stopping situations and reasons of pedestrians passing through each node, and the location and time information of pedestrian stops were recorded.

Previous studies have shown that street elements influence pedestrian walking and stopping behavior. Therefore, in this study, we will further verify the correlation between them by analyzing the pedestrian walking characteristics under the influence of different street elements. Our hypothesis is that under certain specific conditions, certain specific street elements will have a more critical influence on pedestrian walking behavior, making them the core factors influencing pedestrians in specific scenarios. The significance of this research lies in the ability to pinpoint major issues through urban design and more accurately enhance the efficiency and commercial vitality of commercial pedestrian streets (Figure 4).

Figure 4. Selection of Measurement Points. The red shaded areas represent construction zones or entrances/exits of large shopping malls, where pedestrian data collection will not be conducted. Road intersections are delineated during the street segment division process and will not be included in pedestrian data collection. The numerical order in the figure corresponds to the segment numbers in the following text.

2.4.4. Data Analysis

Prior to data collection, training was provided to surveyors through pre-surveys. During the actual data collection process, pedestrian walking and stopping characteristics were comprehensively recorded and monitored through a combination of on-site observation and electronic monitoring. Before conducting data analysis, we first cleaned and preprocessed the collected raw data to ensure accuracy and reliability. Data cleaning primarily involved handling outliers, missing values, and duplicates. We used statistical software to filter and screen the data, excluding any potential outliers. Additionally, missing values were addressed using methods such as interpolation and mean imputation to ensure data integrity and consistency. Furthermore, as required, data variables were standardized to eliminate the influence of different scales on the analysis results, facilitating comparison and analysis.

After organizing and cleaning the collected walking data, the data were inputted into corresponding street node datasets by node. Feature extraction was performed on the raw data to transform complex raw data into meaningful features for subsequent data analysis and modeling. After excluding irrelevant individual information according to data requirements, a total of 1587 sets of valid pedestrian walking data were obtained. These data were quantified and inputted into SPSS 26.0 for further statistical analysis and derivation of research results.

During the data analysis stage, various statistical analysis methods were employed, including descriptive statistical analysis, correlation analysis, and regression analysis, to describe and summarize the basic characteristics of the data. We examined the degree of association and influence among variables and established corresponding models for prediction and interpretation.

3. Results

3.1. Descriptive Statistics

In this study, based on the collected data, we conducted descriptive statistical analysis on both street elements and pedestrian walking and stopping behavior to gain insights into the influence of street elements on pedestrian stopping behavior in commercial pedestrian streets. Integrating these descriptive statistics helps to analyze the characteristics of commercial pedestrian streets and pedestrian stopping behavior more deeply, providing a more comprehensive understanding of pedestrian behavior and preferences on commercial pedestrian streets and offering a scientific basis for the rationalization of pedestrian commercial streets.

In this experiment, a total of 1587 sets of valid walking data were recorded at eight locations, along with pedestrian walking and stopping behavior. By comparing the walking and stopping characteristics of each location in conjunction with the analysis of street element features, some preliminary conclusions can be drawn.

Among the eight surveyed street segment nodes, nodes 4 and 5 have denser public service elements, while nodes 5 and 3 have denser pedestrian interaction elements. Nodes 8 and 2 have the strongest comprehensive display ability of building facades, while the store density is highest at node 3. Overall, 26.21% of pedestrians were attracted to stop during their walking process by street elements; among them, the proportion of pedestrians stopping at nodes 3 and 4 exceeds 40%, with node 3 having significantly higher participation intention, which directly correlates with its higher density of commercial interactive elements compared to the other nodes. Node 4 has the longest stopping time and is the most attractive to pedestrians. Additionally, the proportion of commercial stopping pedestrians at nodes 3 and 4 is also much higher than at other nodes. From these statistical results, it can be analyzed that nodes 3 and 4 stand out in terms of both store density and functional richness, with abundant interactive elements and a high density of public service facilities, creating a good commercial atmosphere and enhancing the spatial activity atmosphere, making them highly attractive to pedestrians (Figures 5 and 6, Tables 4 and 5).

Table 4. Descriptive Statistics of Street Elements in Each Street Segment.

	Street Public Elements		Architectural Interface Elements		Spatial Perception Elements									
Code	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}
Segment	**Density of Public Service Elements**	**Density of Pedestrian Interaction Elements**	**Transparency of Commercial Floor Facades**	**Density of Commercial Display Elements**	**Functional Density**	**Storefront Density**	**Pedestrian Flow**	**Visible Street Greenery Index**	**Street Width-to-Height Ratio**	**Storefront Width-to-Street Width Ratio**	**Street Width**	**Street Elevation Difference**	**Spatial Openness**	**Interface Density**
1	14.10	0	21.69	21.69	3	12	1.85	15.80	1.03	0.57	22.00	7.5	11.33	1
2	20.18	2	62.07	140.85	5	18	1.71	30.65	2.18	0.55	20.36	22.5	7.79	1

Table 4. *Cont.*

	Street Public Elements		Architectural Interface Elements			Spatial Perception Elements								
Code	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}
Segment	**Density of Public Service Elements**	**Density of Pedestrian Interaction Elements**	**Transparency of Commercial Floor Facades**	**Density of Commercial Display Elements**	**Functional Density**	**Storefront Density**	**Pedestrian Flow**	**Visible Street Greenery Index**	**Street Width-to-Height Ratio**	**Storefront Width-to-Street Width Ratio**	**Street Width**	**Street Elevation Difference**	**Spatial Openness**	**Interface Density**
3	24.03	12	55.94	84.95	5	30	4.14	21.65	1.40	0.35	18.87	7	6.07	0.87
4	34.19	8	42.49	67.30	5	20	3.75	36.47	0.91	0.55	18.07	3	6.10	0.87
5	28.58	20	58.06	36.36	4	20	4.32	19.26	1.52	0.47	21.13	7.5	7.12	0.75
6	20.10	2	24.80	44.22	5	18	3.46	18.32	1.62	0.97	20.55	27.5	8.48	0.61
7	26.00	2	28.42	13.78	2	16	2.33	26.22	1.56	0.60	20.80	7.5	7.67	0.90
8	24.00	0	72.15	106.08	2	4	3.74	20.29	1.66	2.25	22.21	30	10.09	0.76

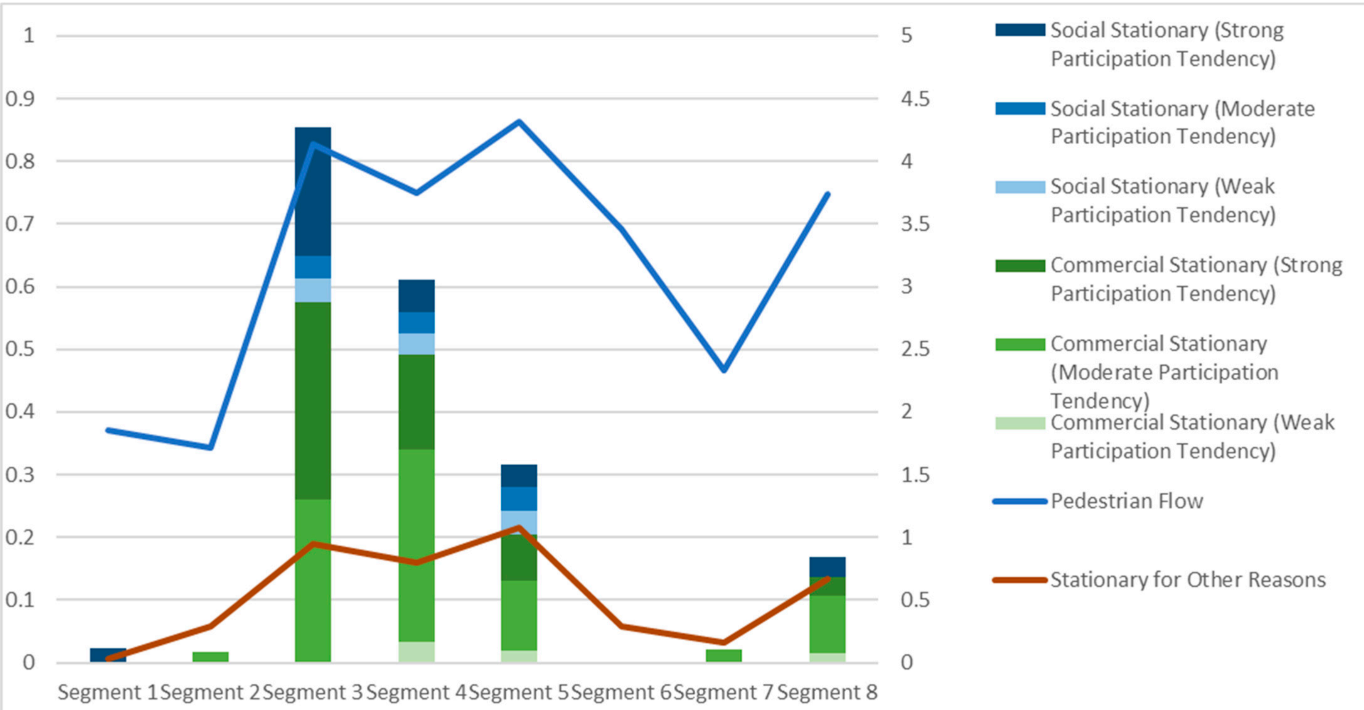

Figure 5. Statistics of Pedestrian Walking and Stationary Characteristics.

Table 5. Descriptive Statistics of Pedestrian Walking Characteristics in Each Street Segment.

Segment	Relative Stopping Time	Walking Average Speed	Participation Tendency	Weak Participation Stopping	Moderate Participation Stopping	Strong Participation Stopping	Commercial Stopping Ratio	Social Stopping Ratio
Unit	s	m/s	%	%	%	%	%	%
1	−1.50	1.67	3.09	1.85	0.00	1.23	0.00	1.23
2	2.29	1.04	20.67	19.71	0.96	0.00	0.96	2.88
3	13.61	0.97	47.09	26.91	7.17	13.00	13.90	9.87
4	22.66	0.92	41.63	27.15	9.05	5.43	13.57	6.93
5	5.42	0.94	32.76	26.72	3.45	2.59	4.74	3.02
6	1.60	1.17	9.89	9.89	0.00	0.00	0.00	1.65
7	1.62	1.36	9.65	9.65	0.00	0.00	0.88	1.75
8	3.51	1.00	26.94	22.86	2.45	1.63	3.67	5.31
Average	6.85	1.08	26.21	19.34	3.34	3.53	5.29	4.41

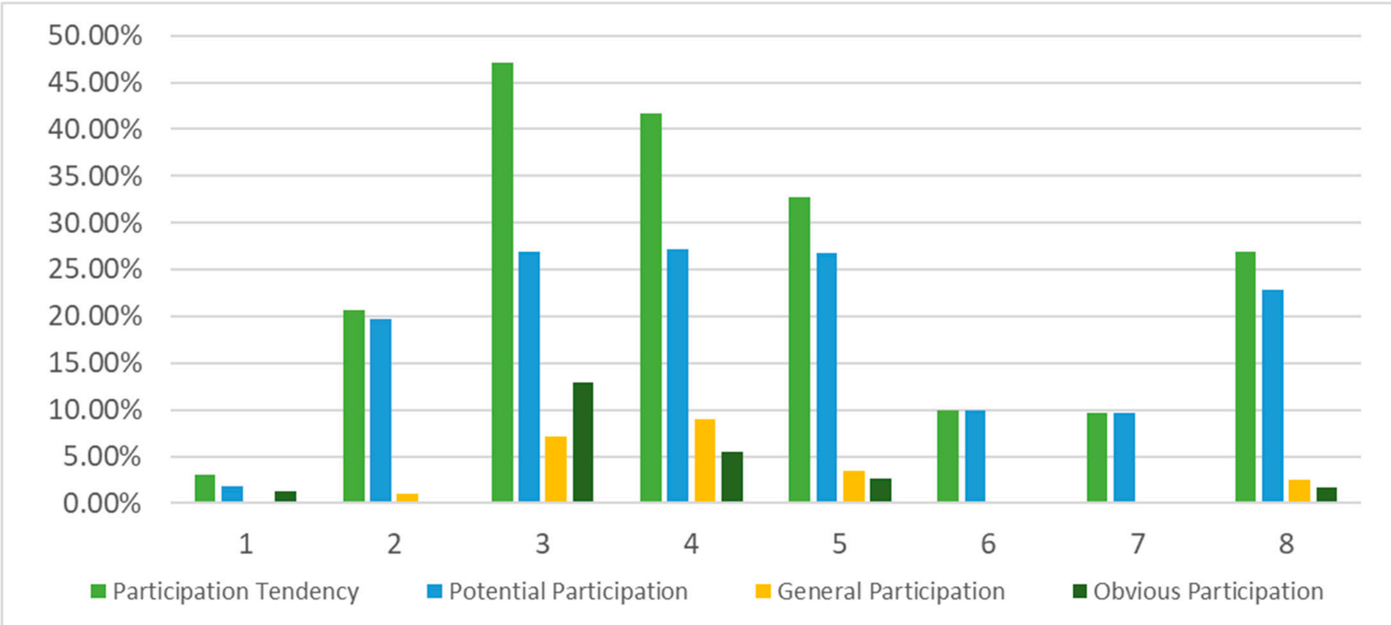

Figure 6. Statistics of Participation Tendency Characteristics.

3.2. Correlation Analysis

To verify whether there is a significant correlation between various street elements and pedestrian walking and stopping behavior, we input the data into SPSS and conducted Pearson correlation analysis to analyze the correlation between each independent variable and the dependent variable. Through correlation analysis, we found that the majority of street elements are significantly positively or negatively correlated with pedestrian stopping behavior. According to the analysis results, it can be seen that most independent variables are significantly correlated with the dependent variable, and the correlations are generally significant at the 0.01 level (two-tailed), indicating support for the association between independent and dependent variables. Most correlation coefficients fall within reasonable ranges, and the direction of correlation between street elements and pedestrian stopping behavior is consistent with our research hypothesis and theoretical expectations. However, it is worth noting that the correlation of certain street elements with pedestrian stopping behavior is not significant ($p > 0.05$), such as the transparency of commercial storefront facades and the street width-to-height ratio. This may be because these elements have relatively minor effects on the pedestrian experience, or there may be other factors influencing them that have not been considered, requiring further analysis and validation to confirm their reliability and accuracy.

In summary, the overall explanatory effect of the model is good and generally meets expectations. Most independent variables are significantly correlated with the dependent variable, and the direction of correlation is consistent with previous assumptions, indicating that the independent variables are likely to have an impact on the dependent variable.

3.3. Regression Analysis

Based on the survey results, we conducted linear regression analysis using SPSS software to examine the relationship between the street elements (independent variables) of urban commercial pedestrian streets and pedestrian stopping behavior (dependent variable). The collected data were processed, including removing outliers, standardization, etc. The data on the dependent variables (pedestrian stopping activity) and independent variables (street environmental elements) of each street segment were analyzed to determine the pairwise correlations between factors. This allowed us to obtain correlation coefficients between various street environmental elements and different types of activities, further analyzing their influence. Using SPSS software, the indicator values of various street elements and pedestrian walking and stopping behavior characteristics were inputted and statistically analyzed. Stepwise regression was chosen for multivariate linear regression analysis to examine the relationship between each independent variable and the dependent variable. In terms of coefficient selection, standardized coefficients were chosen in this experiment to observe the impact of each independent variable on the dependent variable. The magnitude of the standardized coefficients was analyzed to assess the impact of various street elements on pedestrian walking and stopping behavior. Additionally, the significance level (Sig value) representing the significance of each independent variable was selected to observe the correlation between street elements and pedestrian walking and stopping behavior. The Tables 6–10 present the standardized coefficients of each independent variable (street element) with the dependent variable (pedestrian stopping behavior) and their significance levels.

Based on the obtained results, the influence of street elements on pedestrian stopping behavior is complex and diverse. Among them, various factors such as the density of public service elements, density of pedestrian interactive elements, transparency of commercial storefront facades, and pedestrian flow on the street all have a positive impact on encouraging pedestrians to stop and engage in walking activities. There are still some limitations, but the regression model still provides some explanatory power.

1. Interpretation of Street Public Elements:

Overall, the density of public service elements is positively correlated with pedestrian stopping behavior, especially significantly affecting the reduction of average walking speed and alleviation of walking fatigue. However, it is important to note that there is a strong negative correlation between seating density and pedestrian stopping willingness, which is related to the nature of seating itself. Pedestrian interactive elements such as recessed areas, sculptures, interactive animals, and commercial interactive elements are all crucial for promoting pedestrian stopping, especially recessed areas, which have a significant impact on pedestrian stopping behavior and contribute to creating a commercial atmosphere.

2. Interpretation of Architectural Interface Elements:

There is a certain correlation between the transparency of commercial storefront facades and the density of display elements on these facades. Generally, storefronts with good transparency tend to have richer display elements. Both factors have a strong influence on pedestrian stopping behavior, especially on commercial activities. Functional density and storefront density are generally negatively correlated with pedestrian stopping behavior, meaning that more comprehensive and numerous storefronts may be less conducive to pedestrian stopping. However, food and beverage storefronts show a strong positive correlation with pedestrian stopping behavior, as they tend to attract pedestrians with their good transparency and display, enhancing the interest of pedestrians in walking activities.

Table 6. Correlation Analysis of Street Elements and Pedestrian Walking and Stationary Behavior (Pearson).

	Y_1 Pedestrian Stopping Intention	Y_2 Relative Stopping Time	Y_3 Walking Average Speed	Y_4 Participation Tendency	Y_{4-1} Weak Participation Stopping	Y_{4-2} Moderate Participation Stopping	Y_{4-3} Strong Participation Stopping	Y_5 Stopping Reason	Y_{5-1} Commercial Stopping	Y_{5-2} Social Stopping
X_1 Density of Public Service Elements	0.222 **	0.391 **	−0.390 **	0.228 **	0.147 **	0.130 **	0.073 **	0.154 **	0.155 **	0.058 *
X_2 Density of Pedestrian Interaction Elements	0.220 **	0.315 **	−0.314 **	0.226 **	0.136 **	0.104 **	0.129 **	0.142 **	0.143 **	0.053 *
X_3 Transparency of Commercial Floor Facades	0.132 **	0.309 **	−0.320 **	0.121 **	0.144 **	0.014	−0.001	0.038	0.013	0.038
X_4 Density of Commercial Display Elements	0.129 **	0.265 **	−0.256 **	0.126 **	0.113 **	0.032	0.037	0.081 **	0.049	0.063 *
X_5 Functional Density	0.124 **	0.149 **	−0.128 **	0.132 **	0.057*	0.073 **	0.095 **	0.110 **	0.106 **	0.046
X_6 Storefront Density	0.238 **	0.288 **	−0.273 **	0.251 **	0.125 **	0.126 **	0.175 **	0.188 **	0.181 **	0.079 **
X_7 Pedestrian Flow	0.250 **	0.341 **	−0.340 **	0.259 **	0.156 **	0.119 **	0.145 **	0.175 **	0.064 **	0.077 **
X_8 Visible Street Greenery Index	0.177 **	0.326 **	−0.310 **	0.183 **	0.111 **	0.107 **	0.065 **	0.146 **	0.133 **	0.068 **
X_9 Street Width-to-Height Ratio	−0.115 **	−0.018	−0.003	−0.134 **	−0.011	−0.114 **	−0.127 **	−0.147 **	−0.154 **	−0.049
X_{10} Storefront Width-to-Street Width Ratio	−0.193 **	−0.205 **	0.197 **	−0.201 **	−0.107 **	−0.086 **	−0.152 **	−0.137 **	−0.128 **	−0.060 *
X_{11} Street Width	−0.172 **	−0.221 **	0.196 **	−0.186 **	−0.073 **	−0.118 **	−0.126 **	−0.168 **	−0.162 **	−0.069 **
X_{12} Street Elevation Difference	−0.180 **	−0.153 **	0.131 **	−0.198 **	−0.061 *	−0.136 **	−0.154 **	−0.182 **	−0.185 **	−0.067 **
X_{13} Spatial Openness	−0.270 **	−0.371 **	0.358 **	−0.284 **	−0.148 **	−0.145 **	−0.179 **	−0.216 **	−0.203 **	−0.095 **
X_{14} Interface Density	−0.080 **	−0.201 **	0.217 **	−0.075 **	−0.084 **	−0.021	0.012	−0.012	−0.017	0.001

** Significant correlation at the 0.01 level (two-tailed). * Significant correlation at the 0.05 level (two-tailed).

Table 7. Correlation Analysis of Public Service Elements and Pedestrian Walking and Stationary Behavior (Pearson).

	Y_1 Pedestrian Stopping Intention	Y_2 Relative Stopping Time	Y_3 Walking Average Speed	Y_4 Participation Tendency	Y_{4-1} Weak Participation Stopping	Y_{4-2} Moderate Participation Stopping	Y_{4-3} Strong Participation Stopping	Y_5 Stopping Reason	Y_{5-1} Commercial Stopping	Y_{5-2} Social Stopping
X_1 Density of Public Service Elements	0.222 **	0.391 **	−0.390 **	0.228 **	0.147 **	0.130 **	0.073 **	0.154 **	0.155 **	0.058 *
X_{1-1} Bench Density	0.067 **	0.119 **	−0.118 **	0.062 *	0.059 *	0.042	−0.019	0.006	0.033	−0.024
X_{1-2} Flower Bed Density	0.010	−0.035	0.022	0.005	0.026	−0.027	0.007	−0.023	−0.031	−0.001
X_{1-3} Sanitation Facility Density	0.188 **	0.263 **	−0.240 **	0.204 **	0.084 **	0.119 **	0.143 **	0.188 **	0.171 **	0.088 **
X_{1-4} Directional Sign Density	−0.059*	0.048	−0.043	−0.067 **	−0.012	−0.021	−0.107 **	−0.055 *	−0.048	−0.028
X_{1-5} Other Service Facility Density	0.153 **	0.287 **	−0.289 **	0.158 **	0.102 **	0.103 **	0.031	0.107 **	0.115 **	0.032

** Significant correlation at the 0.01 level (two-tailed). * Significant correlation at the 0.05 level (two-tailed).

Table 8. Correlation Analysis of Pedestrian Interaction Elements and Pedestrian Walking and Stationary Behavior (Pearson).

	Y_1 Pedestrian Stopping Intention	Y_2 Relative Stopping Time	Y_3 Walking Average Speed	Y_4 Participation Tendency	Y_{4-1} Weak Participation Stopping	Y_{4-2} Moderate Participation Stopping	Y_{4-3} Strong Participation Stopping	Y_5 Stopping Reason	Y_{5-1} Commercial Stopping	Y_{5-2} Social Stopping
X_2 Density of Pedestrian Interaction Elements	0.220 **	0.315 **	−0.314 **	0.226 **	0.136 **	0.104 **	0.129 **	0.142 **	0.143 **	0.053 *
X_{2-1} Recessed Areas Density	0.278 **	0.348 **	−0.336 **	0.291 **	0.156 **	0.152 **	0.173 **	0.213 **	0.206 **	0.088 **
X_{2-2} Sculpture Density	0.244 **	0.322 **	−0.315 **	0.252 **	0.147 **	0.114 **	0.154 **	0.167 **	0.161 **	0.070 **
X_{2-3} Interactive Animal Density	0.141 **	0.208 **	−0.185 **	0.153 **	0.066 **	0.128 **	0.047	0.141 **	0.149 **	0.047
X_{2-4} Commercial Interactive Element Density	0.140 **	0.181 **	−0.193 **	0.142 **	0.090 **	0.044	0.107 **	0.076 **	0.072 **	0.032

** Significant correlation at the 0.01 level (two-tailed). * Significant correlation at the 0.05 level (two-tailed).

Table 9. Correlation Analysis of Store Density and Pedestrian Walking and Stationary Behavior (Pearson).

	Y_1 Pedestrian Stopping Intention	Y_2 Relative Stopping Time	Y_3 Walking Average Speed	Y_4 Participation Tendency	Y_{4-1} Weak Participation Stopping	Y_{4-2} Moderate Participation Stopping	Y_{4-3} Strong Participation Stopping	Y_5 Stopping Reason	Y_{5-1} Commercial Stopping	Y_{5-2} Social Stopping
X_6 Storefront Density	0.238 **	0.288 **	−0.273 **	0.251 **	0.125 **	0.126 **	0.175 **	0.188 **	0.181 **	0.079 **
X_{6-1} Food Storefront Density	0.249 **	0.320 **	−0.297 **	0.265 **	0.130 **	0.134 **	0.179 **	0.221 **	0.196 **	0.109 **
X_{6-2} Restaurant Storefront Density	0.218 **	0.230 **	−0.205 **	0.240 **	0.081 **	0.144 **	0.198 **	0.232 **	0.210 **	0.109 **
X_{6-3} Street Snack Storefront Density	−0.049	−0.126 **	0.115 **	−0.046	−0.056 *	−0.002	0.006	−0.034	−0.006	−0.040
X_{6-4} Clothing Storefront Density	0.015	0.079 **	−0.082 **	0.014	0.018	0.025	−0.037	−0.010	0.015	−0.029
X_{6-5} Luxury Goods Storefront Density	−0.049	0.004	−0.005	−0.062 *	0.004	−0.051 *	−0.072 **	−0.075 **	−0.075 **	−0.029
X_{6-6} Daily Necessities Storefront Density	0.077 **	0.123 **	−0.104 **	0.080 **	0.040	0.041	0.052 *	0.072 **	0.062 **	0.037
X_{6-7} Cultural Entertainment Storefront Density	−0.021	−0.033	0.018	−0.034	0.020	−0.061 *	−0.021	−0.083 **	−0.076 **	−0.039
X_{6-8} Hotel Density	−0.137 **	−0.117 **	0.113 **	−0.149 **	−0.061 *	−0.090 **	−0.106 **	−0.131 **	−0.122 **	−0.058 *
X_{6-9} Financial Bank Storefront Density	−0.177 **	−0.413 **	0.419 **	−0.175 **	−0.149 **	−0.063 *	−0.040	−0.096 **	−0.080 **	−0.052 *

** Significant correlation at the 0.01 level (two-tailed). * Significant correlation at the 0.05 level (two-tailed).

Table 10. Linear Regression Analysis of Street Elements and Pedestrian Walking and Stationary Behavior.

Standardized Coefficients	Y_1 Pedestrian Stopping Intention	Y_2 Relative Stopping Time	Y_3 Walking Average Speed	Y_4 Participation Tendency	Y_{4-1} Weak Participation Stopping	Y_{4-2} Moderate Participation Stopping	Y_{4-3} Strong Participation Stopping	Y_5 Stopping Reason	Y_{5-1} Commercial Stopping	Y_{5-2} Social Stopping
X_1 Density of Public Service Elements	0.123 **	0.101 **	−0.458 **	0.086 *	0.118 *	0.085 **	0.037	0.060 *	0.081 **	0.023
X_{1-1} Bench Density	−0.110 **	0.065 *	−0.089 **	0.102 **	0.053 *	0.054 *	−0.030	0.020	0.054 *	−0.010
X_{1-2} Flower Bed Density	0.012	−0.018	−0.118 **	0.094 **	−0.058 *	0.019	0.026	0.52 *	0.037	0.036
X_{1-3} Sanitation Facility Density	0.093 **	0.051	−0.025	−0.006	0.101 **	0.000	0.140	−0.010	−0.011	−0.016

Table 10. *Cont.*

Standardized Coefficients	Y_1 Pedestrian Stopping Intention	Y_2 Relative Stopping Time	Y_3 Walking Average Speed	Y_4 Participation Tendency	Y_{4-1} Weak Participation Stopping	Y_{4-2} Moderate Participation Stopping	Y_{4-3} Strong Participation Stopping	Y_5 Stopping Reason	Y_{5-1} Commercial Stopping	Y_{5-2} Social Stopping
X_{1-4} Directional Sign Density	0.056 *	0.038	0.083 **	−0.045	−0.013	0.001	−0.040 **	−0.018	−0.016	−0.009
X_{1-5} Other Service Facility Density	−0.050	0.082	−0.110 **	0.056	0.095 **	0.064 *	0.026	−0.017	0.053 **	0.021
X_2 Density of Pedestrian Interaction Elements	0.084 *	0.042	−0.073 **	0.068 **	0.105 **	0.048	0.018	0.047	0.064 **	0.017
X_{2-1} Recessed Areas Density	0.278 **	0.089 **	−0.177 **	0.170 **	0.130 **	0.082 *	0.173 **	0.051	0.089 **	0.018
X_{2-2} Sculpture Density	−0.022	0.046	−0.140 **	0.137 **	0.120 **	0.042	0.161 **	0.034	0.054	−0.013
X_{2-3} Interactive Animal Density	0.015	0.107 **	−0.104 **	−0.012	0.091 **	0.061 *	0.047	−0.004	0.036	0.019
X_{2-4} Commercial Interactive Element Density	0.091 **	0.020	−0.086 **	0.109 **	0.058 *	0.033	0.048	0.028	0.043	−0.003
X_3 Transparency of Commercial Floor Facades	0.154 **	0.066 **	−0.149 **	0.112 **	0.167 **	0.059 *	0.072 **	0.104 **	0.080 **	0.072 **
X_4 Density of Commercial Display Elements	0.086 **	0.008	−0.050	0.054 *	0.030	0.006	0.035	0.044	0.010	−0.044
X_5 Functional Density	0.000 **	−0.108 **	−0.029	−0.050	0.084 **	−0.084 *	0.037 **	−0.106 **	−0.105 *	−0.060
X_6 Storefront Density	−0.087 *	0.000 **	−0.071 **	0.098 **	0.000	−0.040	0.166 **	−0.010	−0.013	−0.004
X_{6-1} Food Storefront Density	0.124 **	−0.049	−0.080 **	0.134 **	0.093 **	−0.037	0.214 **	0.069	0.009	0.122 **
X_{6-2} Restaurant Storefront Density	0.109 **	0.257 **	−0.107 **	0.308 **	0.101 **	0.014 **	0.221 **	0.220 **	0.230 **	0.057
X_{6-3} Street Snack Storefront Density	−0.108 **	−0.031	0.050 *	−0.057 *	0.010	−0.016	0.005	−0.048 *	−0.026	−0.013
X_{6-4} Clothing Storefront Density	−0.078 **	0.051 *	0.062 **	−0.004	0.074 **	0.018	−0.047	−0.016	0.012	−0.039
X_{6-5} Luxury Goods Storefront Density	0.049 *	−0.002	0.025	−0.003	−0.051	−0.012	−0.072 **	−0.006	−0.017	−0.006
X_{6-6} Daily Necessities Storefront Density	0.057 *	0.005	0.025	−0.027	0.022	−0.019	0.031	−0.019	−0.025	−0.022
X_{6-7} Cultural Entertainment Storefront Density	−0.059 *	0.007	−0.030	0.111 **	−0.003	0.017	−0.022 **	0.026	0.033	−0.022
X_{6-8} Hotel Density	−0.001	−0.010	0.144 **	−0.055	−0.040	−0.035	−0.106 **	−0.034	−0.041	−0.042 *
X_{6-9} Financial Bank Storefront Density	−0.016 **	−0.048	0.331 **	−0.081 **	−0.085 **	−0.029	−0.040	−0.038	−0.030	−0.011
X_7 Pedestrian Flow	0.154 **	0.093 **	−0.125 **	0.151 **	0.106 **	0.076 **	0.090 **	0.107 **	0.107 **	0.061
X_8 Visible Street Greenery Index	−0.018	−0.006	−0.077 **	−0.037	0.061 *	−0.005	−0.016	0.062	−0.054	−0.039
X_9 Street Width-to-Height Ratio	−0.052 *	−0.072 **	0.113 **	−0.101 **	−0.088 **	0.054 *	−0.068 **	−0.040	−0.067 *	−0.008
X_{10} Storefront Width-to-Street Width Ratio	0.145 **	0.087 **	0.033	0.106 **	−0.079 **	−0.055	−0.186 **	0.096 **	0.070 *	0.069 **
X_{11} Street Width	−0.016	−0.248 **	0.082 **	−0.115 *	−0.115 **	−0.143 **	−0.059	−0.173 **	−0.196 **	−0.087 **
X_{12} Street Elevation Difference	0.002	−0.031	0.124 **	−0.048 **	−0.095 **	−0.038	−0.031	−0.012	−0.047	0.012
X_{13} Spatial Openness	−0.244 **	−0.005	0.130 **	−0.259 **	−0.122 **	−0.030	−0.012	−0.029	−0.034	−0.014
X_{14} Interface Density	−0.008	−0.027	−0.029	0.026	−0.039	−0.040	−0.095 *	−0.009	−0.021	0.002

** Significant correlation at the 0.01 level (two-tailed). * Significant correlation at the 0.05 level (two-tailed). Standardized coefficients: These coefficients indicate the effect of independent variables on the dependent variable. A positive coefficient indicates a positive effect of the independent variable on the dependent variable, while a negative coefficient indicates a negative effect. The larger the coefficient value, the greater the impact of the independent variable on the dependent variable.

3. Interpretation of Spatial Perception Elements:

Pedestrian flow on the street is crucial for encouraging pedestrian stopping behavior. In public spaces, people are easily attracted by the activities of others, leading to gatherings and further promoting walking behavior. Regarding street width and the street width-to-height ratio, due to the limited fluctuation in building heights along commercial pedestrian streets, there is a strong correlation between street width and this ratio. Increasing street width and the D/H ratio tends to decrease overall pedestrian stopping behavior and willingness to participate. Widening sidewalks does not necessarily increase pedestrian stopping, and controlling sidewalk width within a certain range is actually conducive to various walking activities.

The storefront width-to-street width ratio shows an overall positive correlation with pedestrian stopping behavior. Generally, when this ratio is controlled between 1 and 1.5, pedestrians tend to stop more frequently. This conclusion also reflects the negative impact of street width on pedestrian stopping behavior. Street level changes are generally negatively correlated with pedestrian stopping behavior, especially significantly affecting walking speed. Larger level changes also hinder pedestrian–environment interactions, reducing pedestrian participation. Spatial openness, as a variable describing open spaces such as squares, has its limitations in describing street spatial conditions. Higher spatial openness implies fewer facility elements and storefronts on the street, which is not conducive to walking activities, thus showing a significant negative correlation with various pedestrian walking activities. The green view ratio and interface density have a relatively low overall impact on pedestrian stopping behavior, only showing some influence on individual aspects such as walking speed and participation tendency, but they are not key factors affecting pedestrian stopping behavior.

3.4. Main Factor Analysis

According to the characteristics of pedestrian walking and stopping, the main independent variables that have the most significant impact on each dependent variable are sorted as follows (Figure 7, Table 11).

3.4.1. Pedestrian Stopping Willingness

Pedestrian stopping willingness is a crucial indicator of whether pedestrians are willing to stop on commercial pedestrian streets. For pedestrian stopping willingness, a total of 23 factors have a significant impact, among which recessed areas, facade transparency, pedestrian flow, and storefront width-to-street width ratio are the main factors with strong positive effects on pedestrian stopping willingness. In other words, the presence of recessed areas, high pedestrian density, and a higher storefront width-to-street width ratio increase pedestrians' willingness to stop, while spatial openness has a strong negative impact, meaning that higher spatial openness leads to lower pedestrian stopping willingness.

3.4.2. Relative Stopping Time

Relative stopping time reflects the duration of pedestrian stops in commercial pedestrian streets and is an objective indicator of the attractiveness of stages to pedestrians. For pedestrian relative stopping time, a total of 14 factors have a significant impact. Among them, food and beverage storefront density, interactive animals, and public service element density are the three main factors with a strong positive effect on pedestrian stopping willingness, i.e., when the density of food and beverage storefronts, interactive animals, and public service elements increases, pedestrians tend to stay longer in commercial pedestrian streets. However, street width and functional density have a negative impact, meaning that wider streets and more complex storefront functions deter pedestrians from stopping.

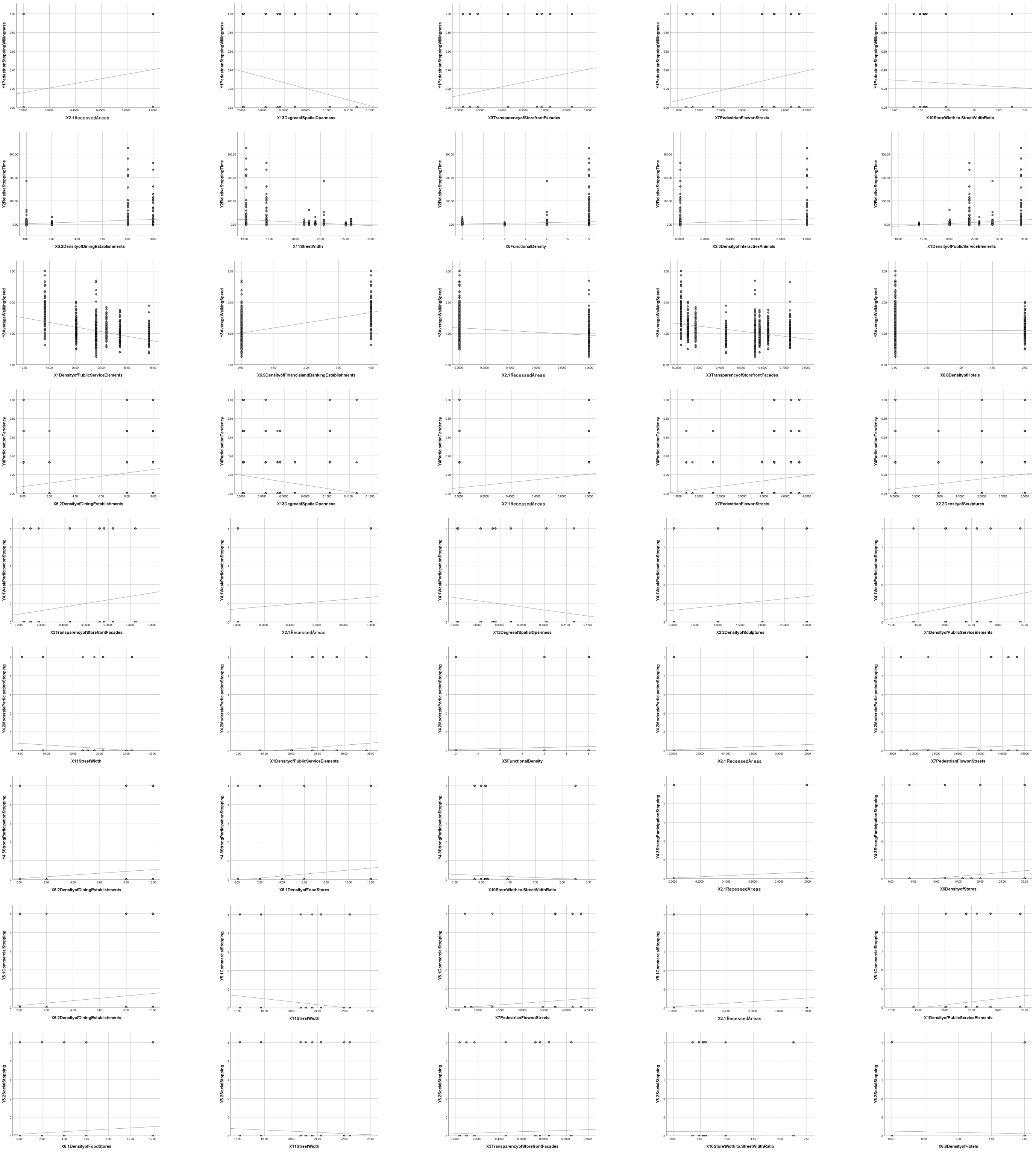

Figure 7. Linear Regression Analysis of Main Factors Affecting Pedestrian Walking and Stationary Behavior.

Table 11. Main Factors Affecting Pedestrian Walking and Stationary Behavior.

Characteristics of Pedestrian Walking and Stationary Behavior	**Major Influencing Factors**				
Y_1 Pedestrian Stopping Intention	X_{2-1} Recessed Areas Density	X_{13} Spatial Openness	X_3 Transparency of Commercial Floor Facades	X_7 Pedestrian Flow	X_{10} Storefront Width-to-Street Width Ratio
	0.278 **	−0.244 **	0.154 **	0.154 **	0.145 **
Y_2 Relative Stopping Time	X_{6-2} Restaurant Storefront Density	X_{11} Street Width	X_5 Functional Density	X_{2-3} Interactive Animal Density	X_1 Density of Public Service Elements
	0.257 **	−0.248 **	−0.108 **	0.107 **	0.101 **
Y_3 Walking Average Speed	X_1 Density of Public Service Elements	X_{6-9} Financial Bank Storefront Density	X_{2-1} Recessed Areas Density	X_3 Transparency of Commercial Floor Facades	X_{6-8} Hotel Density
	−0.458 **	0.331 **	−0.177 **	−0.149 **	0.144 **
Y_4 Participation Tendency					
Y_4 Participation Tendency	X_{6-2} Restaurant Storefront Density	X_{13} Spatial Openness	X_{2-1} Recessed Areas Density	X_7 Pedestrian Flow	X_{2-2} Sculpture Density
	0.308 **	−0.259 **	0.170 **	0.151 **	0.137 **
Y_{4-1} Weak Participation Stopping	X_3 Transparency of Commercial Floor Facades	X_{2-1} Recessed Areas Density	X_{13} Spatial Openness	X_{2-2} Sculpture Density	X_1 Density of Public Service Elements
	0.167 **	0.130 **	−0.122 **	0.120 **	0.118 *
Y_{4-2} Moderate Participation Stopping	X_{11} Street Width	X_1 Density of Public Service Elements	X_5 Functional Density	X_{2-1} Recessed Areas Density	X_7 Pedestrian Flow
	−0.143 **	0.085 **	−0.084 *	0.082 *	0.076 **
Y_{4-3} Strong Participation Stopping	X_{6-2} Restaurant Storefront Density	X_{6-1} Food Storefront Density	X_{10} Storefront Width-to-Street Width Ratio	X_{2-1} Recessed Areas Density	X_6 Storefront Density
	0.221 **	0.214 **	−0.186 **	0.173 **	0.166 **
Y_5 Stopping Reason *	\	\	\	\	\
Y_{5-1} Commercial Stopping	X_{6-2} Restaurant Storefront Density	X_{11} Street Width	X_7 Pedestrian Flow	X_{2-1} Recessed Areas Density	X_1 Density of Public Service Elements
	0.230 **	−0.196 **	0.107 **	0.089 **	0.081 **
Y_{5-2} Social Stopping	X_{6-1} Food Storefront Density	X_{11} Street Width	X_3 Transparency of Commercial Floor Facades	X_{10} Storefront Width-to-Street Width Ratio	X_{6-8} Hotel Density
	0.122 **	−0.087 **	0.072 **	0.069 **	0.042 **

**. Significant correlation at the 0.01 level (two-tailed). *. Significant correlation at the 0.05 level (two-tailed). Y_5 Stopping Reason: The data for Stopping Reason's Major Influencing Factors is not of practical significance and will not be discussed in this table.

3.4.3. Average Walking Speed

Average walking speed reflects pedestrians' affinity for surrounding street elements. For pedestrian average walking speed, a total of 25 factors have a significant impact. Among them, financial bank storefront density and hotel density are the main factors that have a strong positive effect on pedestrian average walking speed. This means that higher densities of financial banks and hotels lead to faster pedestrian average walking speeds and less willingness to linger. On the other hand, the density of public service elements, recessed areas, and commercial storefront facade transparency have a negative impact, indicating that denser public service elements, the presence of recessed areas, and better storefront transparency result in slower pedestrian walking speeds and a greater willingness to stop.

3.4.4. Participation Tendency

Participation tendency refers to the extent to which pedestrians engage with the surrounding environment in commercial pedestrian streets. For pedestrian participation tendency, a total of 24 factors have a significant impact. Among them, food and beverage storefront density, recessed areas, street pedestrian flow, and sculpture density are the main factors with a strong positive effect on pedestrian participation tendency. This means that higher densities of food and beverage storefronts, recessed areas, and sculptures, as well as greater pedestrian flow, lead to a higher participation tendency and a greater desire to engage in interactions. However, spatial openness has a significant negative impact, indicating that more open space leads to a lower participation tendency and less willingness to engage.

3.4.5. Reasons for Stopping

Regarding reasons for stopping, commercial and social stopping are discussed separately. For commercial stopping, 12 factors have a significant impact. Among them, food and beverage storefronts, pedestrian flow, recessed areas, and public service elements play an important role in promoting commercial stopping behavior. Higher densities of food and beverage storefronts, more recessed areas, and denser public service facilities, as well as greater pedestrian flow, lead to a stronger willingness to participate in commercial activities. However, street width shows a significant negative correlation with commercial stopping behavior, meaning that wider roads lead to a weaker willingness to engage in commercial activities. For social stopping, five factors have a significant impact. Among them, food and beverage storefront density, hotel storefront density, storefront transparency, and street width-to-height ratio play a significant role in promoting social stopping behavior. Higher densities of food and beverage storefronts and hotels, better storefront transparency, and livelier storefronts lead to a stronger willingness to participate in social activities. However, street width also shows a significant negative correlation with social stopping behavior, indicating that wider roads lead to a weaker willingness to engage in social activities.

4. Discussion

Research indicates that street elements have a significant impact on pedestrian stopping behavior, with regression models showing relatively good explanatory power in terms of pedestrian stopping willingness (adjusted R^2 = 0.104) and average walking speed (adjusted R^2 = 0.351). The proper configuration of street elements is crucial for creating a vibrant and comfortable pedestrian space. Street nodes with rich and interesting content exhibit significantly higher pedestrian activity compared to dull and monotonous nodes. Based on field research and data analysis, the following recommendations are summarized.

4.1. Recommendations for Creating Commercial Pedestrian Streets from the Perspective of Commercial Vitality

High-quality pedestrian experiences are indispensable for vibrant streets; improving walkability and enhancing the pedestrian environment are proven strategies for invigorating overlooked spaces within the urban landscape [40]. From the perspective of commercial vitality, the design of commercial pedestrian streets should promote pedestrian stopping behavior, especially commercial stopping behavior, and enhance pedestrian participation willingness. At the same time, to improve the efficiency of commercial promotion, pedestrian walking speed should be slowed down as much as possible. Based on these premises, we have derived some important influences of street elements on pedestrian stopping behavior and propose the following recommendations.

4.1.1. Recessed Areas Are Key Elements for Promoting Pedestrian Stopping Behavior

Recessed areas (X_{2-1}) are the most critical factor in enhancing urban vitality and promoting interaction, exerting the strongest comprehensive influence on pedestrian stopping behavior out of 32 factors. Recessed areas create warm and complete urban spaces by utilizing "shade" to enclose spatial domains. They provide gathering places for resting and communication, create a conducive walking environment, and stimulate pedestrians' willingness to walk [12]. Recessed areas, with their outdoor and plaza-like characteristics, present an open state to the outside. In his works, Tadao Ando underscores the significance of spaces that foster interaction, asserting that architecture devoid of human engagement severs its essence from the spatial experience [41]. Within open settings, the dynamic interplay between individuals and public spaces not only elevates the aesthetic and functional caliber of the landscape but also invigorates the urban tapestry with renewed vitality [42]. Furthermore, block-style commercial layouts enhance interactions between people and further promote active communication and business interactions within the community.

4.1.2. Street Elevation Differences Have a Significant Negative Impact on Commercial Activities

Street elevation differences (X_{12}) are a significant factor affecting pedestrian activities and can have a strong negative impact on the overall walking and stopping behavior of pedestrians. The presence of elevation differences reduces accessibility for pedestrians, which is detrimental to the conduct of commercial activities [43]. Significant street level differences severely hinder pedestrian accessibility, especially for groups with lower walking willingness such as people with disabilities, the elderly, and tired pedestrians, leading to a significant reduction in their willingness to walk and the mobility and flow of commercial activities. Moreover, differences in street level restrict the space for merchants to set up displays or place goods in external spaces, thereby reducing display effectiveness and commercial appeal, which is highly detrimental to commercial activities. In this survey, several nodes with the best commercial performance (Nodes 3, 4, and 7) have differences in street level that are controlled within one step, with flat roads, which contributes to relatively dynamic commercial activity.

4.1.3. Concentration of Restaurant Storefronts Helps Increase Commercial Appeal

Contrary to expectations, a higher number and variety of storefronts do not necessarily lead to better commercial performance. Some areas with a relatively simple storefront structure have more pedestrian stops, while areas with a wide variety of storefronts have lower pedestrian stopping willingness. Thus, the density of functional storefronts shows a certain negative correlation with pedestrian stopping behavior in some aspects. Typically, restaurant storefronts (X_{6-2}) stand out as the most significant catalyst for street vibrancy [44]. In our experiment, we found that areas with a high incidence of pedestrian stopping behavior are often characterized by a concentration of restaurant storefronts and a relatively uncomplicated commercial layout. This relatively simple thematic aggregation creates clear points of attraction and garners more attention. Coupled with the good transparency and display of food and beverage storefronts, once a cluster is formed, it is easy to create a good spatial atmosphere and experiential feeling, greatly increasing commercial appeal and attracting pedestrians.

4.1.4. Facade Transparency Significantly Promotes Commercial Activities

The Transparency of Commercial Floor Facades (X_3) contributes to enhancing interactions between people and buildings, effectively guiding pedestrian flow and significantly boosting the likelihood of pedestrian stops and the vibrancy of commercial activities [45]. Facades with high transparency allow pedestrians to clearly see the displays and products inside the shops from the outside, visually eliminating the sense of disconnection between storefronts and streets and creating a continuous, open visual experience. The stronger this sensory attraction, the more attention it attracts from pedestrians, promoting stopping and participation.

In conclusion, street elements universally influence the commercial vitality of commercial pedestrian streets by affecting pedestrian stopping behavior, with some key elements having the most significant impact. From this perspective, designers can positively influence the commercial vitality of streets by reasonably adjusting the selection of street elements, providing important insights for the design of commercial pedestrian streets.

4.2. Pedestrian Preferences in Walking and Stopping from the Perspective of Pedestrians

Understanding pedestrian walking and stopping preferences is crucial in the design and planning process of commercial pedestrian streets. From the perspective of pedestrians, different street elements elicit various walking and stopping preferences. By analyzing key influencing factors, the following conclusions are drawn.

4.2.1. Public Service Elements Promote Pedestrian Stopping

Intensive public service elements (X_1) can stimulate the latent desire of pedestrians to stay [46]. An increase in the density of public service elements usually means more convenience and service facilities. This provides more opportunities for rest and convenience, enhances interest in walking, and alleviates walking fatigue, making pedestrians more willing to stop. However, it is important to note that there is a strong negative correlation between the density of seats and pedestrian stopping willingness. An increase in seat density objectively compresses street space, disrupts the smooth flow of walking, and reduces pedestrian comfort and environmental perception to some extent.

4.2.2. Attracting and Guiding Pedestrian Flow Contributes to the Formation of a Virtuous Cycle

According to data analysis, pedestrian flow (X_7) on streets significantly influences attracting pedestrians to stop. It plays a vital role in enhancing pedestrian stopping willingness, reducing walking speed, extending stopping time, and increasing the tendency for pedestrians to participate. The busiest street segments (Nodes 3, 4, 5, and 8) also have the highest proportion of pedestrian stops. From the perspective of social psychology, in crowded places, pedestrians may be influenced by social norms and adjust their behavior based on the actions of others to conform to social norms. When many people stop, other pedestrians are more likely to stop too, following the trend of group behavior [47]. An environment with a concentrated pedestrian flow provides more social support and a sense of security, creating more opportunities for social interaction and engagement, thus prompting pedestrians to actively stop and participate in social activities. Places with dense pedestrian flow often become ideal places for attracting pedestrian stops [23]. Therefore, in urban planning and design, full consideration should be given to how to attract and guide pedestrian flow, promote a virtuous cycle, and create a more attractive and vibrant urban environment.

4.2.3. Street Width Is an Important Factor Affecting Pedestrian Walking and Stopping Activities

Data show that street width (X_{11}) is one of the main factors affecting pedestrian stopping time and participation tendency. Both street width and the street's width/height ratio exhibit significant negative correlations with pedestrian stopping behavior, while the storefront width/street width ratio correlates positively. These findings reflect the adverse effects of excessively wide streets on pedestrian walking activities. Narrower streets foster a greater sense of security and coziness for pedestrians, effectively shrinking the perceived distance of a walk in their minds and potentially boosting their inclination to walk. On the other hand, when the street width surpasses a comfortable limit, an expansion in width can notably increase the psychological gap between pedestrians and the environment, making the act of crossing the street more time-consuming and laborious, thus reducing the pedestrian's desire to undertake the journey on foot [48]. According to Yang Gail's viewpoint, the most intense communication distance for humans should be controlled to within 7 m. Excessively wide sidewalks may lead to pedestrian dispersion, reducing contact and communication opportunities and diluting visual attractiveness and focus. Beyond a certain width, streets will have a negative impact on both commercial and social activities [46]. The scale of the street significantly influences the comfort and sense of security that pedestrians perceive. Psychologically, wide streets are often perceived as thoroughfares rather than places for rest, which can lead to feelings of isolation or indifference. This perception generates a sense of insecurity, thereby reducing the likelihood of stopping behavior. In contrast, narrow streets may offer more opportunities for pedestrians to make temporary stops or observe their surroundings. The sense of enclosure they create makes people feel safer and more comfortable, thus increasing their willingness to stop [49].

In conclusion, although individuals may perceive street elements differently, some key street elements will generally have a widespread impact on most pedestrians. From the perspective of urban design, designers can reasonably arrange elements and guide pedestrian behavior according to different practical needs, enhancing the efficiency of different designs.

4.3. Limitations and Future Research Directions

This study has certain limitations: Firstly, the selected streets have specific characteristics, which may hinder the statistical analysis of some factors influencing pedestrian stopping behavior. These factors include street slope, street curvature, and walking continuity, which may show insignificant results due to small variations. The exclusion of these factors, which may be important in certain environments, limits the generalizability of the conclusions of this study to some extent. In future research, the model should be further improved to explore more influencing factors, combined with field observations and experimental verification, to further enrich the model's coverage and provide more scientific and effective suggestions for the design and improvement of commercial pedestrian streets. Secondly, due to the exclusion of pedestrian stopping behavior with strong purposiveness in the pedestrian selection process, some statistical results fluctuated and the correlation between variables was affected to a certain extent. In the subsequent data interpretation process, comprehensive consideration and review of the data are needed to better guide the design and improvement of commercial pedestrian streets.

This work thoroughly explores the impact of street elements on pedestrian stopping behavior in commercial pedestrian streets and has certain practical significance.

4.3.1. Improving Urban Space Quality

The research results contribute to understanding the impact of street elements on urban space quality, providing theoretical support for improving the urban environment. By optimizing street element design, more comfortable and pleasant urban environments can be created, enhancing the quality of life of residents.

4.3.2. Promoting Business Development

As an important carrier of urban commercial activities, the rational design and layout of street elements are crucial for business development. The research results help businesses understand how to attract customers and improve commercial efficiency by optimizing street elements, thereby promoting business development.

4.3.3. Enhancing Community Connections

Commercial pedestrian streets are not only places for commercial activities but also places for community residents to interact. Improvements in street elements can promote people staying and interacting on commercial pedestrian streets, strengthening community connections, enhancing neighborly relations, and creating a harmonious community atmosphere.

4.3.4. Sustainable Development

The reasonable design of street elements in commercial pedestrian streets helps increase pedestrian frequency and interest in walking. By deeply studying the impact of street elements on pedestrian stopping behavior in commercial pedestrian streets, guidance can be provided for urban planning and design. The reasonable layout and design of street elements help enhance the attractiveness of commercial pedestrian streets and promote pedestrian stays and interactions, thereby enhancing commercial vitality and the urban image and promoting sustainable development.

5. Conclusions

This study measured pedestrian walking characteristics in different street environments and verified the significant correlation between street elements and pedestrian walking and stopping behavior. Through a series of statistical analyses, the following conclusions were drawn.

Public service elements (X_1) (including benches (X_{1-1}), flower beds (X_{1-2}), sanitation facilities (X_{1-3}), directional signs (X_{1-4}), etc. (X_{1-5})), pedestrian interaction elements (X_2) (recessed areas (X_{2-1}), sculptures (X_{2-2}), interactive animals (X_{2-3}), and commercial interaction facilities (X_{2-4})), transparency of commercial floor facades (X_3), and density of commercial display elements (X_4), among other street elements of commercial pedestrian streets, have varying degrees of influence on pedestrian walking and stopping behavior (including pedestrian stopping intention (Y_1), relative stopping time (Y_2), walking average speed (Y_3), participation tendency (Y_4), stopping reasons (Y_5), etc.).

Regarding pedestrian stopping intention (Y_1), the main influencing factors are recessed areas (X_{2-1}, β = 0.278, $p < 0.01$), spatial openness (X_{13}, β = −0.244, $p < 0.01$), transparency of commercial floor facades (X_3, β = 0.154, $p < 0.01$), pedestrian flow (X_7, β = 0.154, $p < 0.01$), and the ratio of storefront width to street width (X_{10}, β = 0.145, $p < 0.01$).

In terms of relative stopping time (Y_2), the most significant influencing factors are the density of restaurant storefronts (X_{6-2}, β = 0.257, $p < 0.01$), street width (X_{11}, β = −0.248, $p < 0.01$), functional density (X_5, β = −0.108, $p < 0.01$), interactive animal density (X_{2-3}, β = 0.107, $p < 0.01$), and the density of public service elements (X_1, β = 0.101, $p < 0.01$).

For average walking speed (Y_3), the most significant influencing factors are the density of public service elements (X_1, β = −0.458, $p < 0.01$), the density of financial bank storefronts (X_{6-9}, β = 0.331, $p < 0.01$), recessed areas (X_{2-1}, β = −0.177, $p < 0.01$), transparency of commercial floor facades (X_3, β = −0.149, $p < 0.01$), and hotel density (X_{6-8}, β = 0.144, $p < 0.01$).

In terms of participation tendency (Y_4), the most significant influencing factors are the density of restaurant storefronts (X_{6-2}, β = 0.308, $p < 0.01$), spatial openness (X_{13}, β = −0.259, $p < 0.01$), recessed areas (X_{2-1}, β = 0.170, $p < 0.01$), pedestrian flow (X_7, β = 0.151, $p < 0.01$), and the density of sculptures (X_{2-2}, β = 0.137, $p < 0.01$). For different levels of participation, transparency of commercial floor facades (X_3, β = 0.167, $p < 0.01$) has the most significant impact on weak participation stopping (Y_{4-1}); street width (X_{11}, β = −0.143, $p < 0.01$) has the most significant impact on moderate participation stopping (Y_{4-2}); and the density of restaurant storefronts (X_{6-2}, β = 0.221, $p < 0.01$) has the most significant impact on strong participation stopping (Y_{4-3}).

Regarding stopping reasons (Y_5), the factors with the greatest impact on commercial stopping (Y_{5-1}) are the density of restaurant storefronts (X_{6-2}, β = 0.230, $p < 0.01$), street width (X_{11}, β = −0.196, $p < 0.01$), pedestrian flow (X_7, β = 0.107, $p < 0.01$), recessed areas

(X_{2-1}, β = 0.089, $p < 0.01$), and the density of public service elements (X_1, β = 0.081, $p < 0.01$). For social stopping (Y_{5-2}), the most significant factors are the density of food stores (X_{6-1}, β = 0.122, $p < 0.01$), street width (X_{11}, β = −0.087, $p < 0.01$), transparency of commercial floor facades (X_3, β = −0.072, $p < 0.01$), the ratio of storefront width to street width (X_{10}, β = 0.069, $p < 0.01$), and hotel density (X_{6-8}, β = 0.042, $p < 0.01$).

This study offers significant theoretical contributions and practical insights into the field of urban planning by conducting an in-depth analysis of how elements of commercial streets influence pedestrian stopping behavior. Our findings have not only expanded the theoretical framework of urban design but also provided urban planners with concrete design principles and actionable strategies.

Theoretical Contributions: This research distinctly outlines the impact of key street elements in commercial pedestrian zones on the walking characteristics of pedestrians. Utilizing quantitative analysis, it uncovers how the design of street elements affects pedestrians' willingness to stop and their behavioral patterns. This insight aids urban planners in comprehending more deeply the interplay between urban spaces and user behavior, thereby enriching the theoretical underpinnings of what constitutes vibrant commercial streets.

Practical Value: This study provides an empirical foundation for the urban design of commercial streets, presenting key performance indicators aligned with diverse redevelopment goals. This enables professionals to strategically employ specific measures such as enhancing street landscapes, refining pedestrian facilities, and adding leisure spaces to transform streets effectively. Different street elements, when effectively set up, can guide the characteristics of pedestrians' walking behavior to serve various street functions. Equipping urban planning practitioners with scientific assessment tools and design guidelines facilitates rational decision-making throughout the design process. Understanding the link between pedestrian stopping behavior and urban elements clearly empowers practitioners to efficiently stimulate commercial activity, elevate the quality of life of residents, and foster sustainable urban development.

In conclusion, by constructing a network of the relationship between street elements and pedestrian walking and stopping behavior, and clarifying the impact of different elements on various walking behaviors, this study has achieved practically meaningful research results in the field of street design and sustainable development of living environments. Street design, besides fulfilling its basic functional requirements, must deeply understand the characteristics and inner needs of its users. Reasonable design helps create sustainable, vibrant living environments, promotes the physical and mental health of users, meets different practical needs, and enhances space utilization efficiency.

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