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The Influence of the Built Environment in the Spatial Behavior of Street Vendors

The Case of Mercado Central and Mesa Redonda
in Lima´s Historic Center

M.Sc. Integrated Urban Development and Design
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Abstract

Informality plays a crucial role in developing economies. In Peru, 70% of employment is informal, with 19% from commercial activities such as street vending. While street vending is a significant component of the economy and fosters urban social interaction, unregulated practices can lead to mobility, environmental and safety issues. Authorities often respond with relocation strategies; however, these have frequently been unsuccessful, indicating a need for a new approach that focuses on reorganizing vendors within their existing locations.

To ensure the quality of the urban environment, while addressing the economic needs of street vendors, it is essential for urban planners and managers to understand the spatial behavior patterns of street vendors in relation to the built environment.

This research looks at one specific case, the area of Mercado Central and Mesa Redonda in Lima´s Historic Center. In this site, the Municipality faces constant challenges to regulate the activity and spatial occupation of the street vendors. The main goal is to understand which and how specific characteristics of the built environment influence the spatial distribution and occupation patterns of street vending. The findings will provide insights into street vendors´ spatial behavior that should be taken in consideration when planning a reorganization of vendors in this area.

The research uses a combined quantitative and qualitative methodology to analyze the relationships between selected characteristics of the built environment and the spatial behavior patterns of street vending. Using computational analysis, correlations are calculated between the density distribution of different types of street vendors and built environment variables, such as street functionality type, density of retail entrances, pavement width, opportunity space and visibility. The qualitative findings, are complemented by interviews to street vendors and site-observations to obtain final results.

The findings show the strength, dynamics and variations of the influence of the selected built environment variables in the spatial behavior pattern of different types of street vending in the study area, offering valuable insights and suggestions for future guidelines for vendor´s reorganization in the study area.

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1. Introduction

1.1. Problem statement

> *"Quizás quienes desde hace varias décadas ocupan terrenos estatales, los vendedores ambulantes y los empresarios informales no son el gran problema de Latino América, sino la solución."* [Perhaps those who have occupied state land for several decades, street vendors and informal entrepreneurs are not the great problem in Latin America, but the solution.] (De Soto, 2000)

Informality plays a crucial role in developing economies. The majority of entrepreneurial activity in third-world countries operates in the informal sector (De Soto, 2000). In Peru, 70% of employment is informal, with 19% coming from commercial activities, such as street vending (INEI Instituto Nacional de Estadística e Informática, 2022).

Street vending is a traditional and historical practice in Lima, with its origins during colonial times in the 16th century (Rivasplata Varillas, 2024). Today, it remains a vital economic livelihood for many families and in recent decades its practice has grown due to migration processes and economic instability, which produces unemployment (Diaz Guevara & Quito Torres, 2022). In this context, street vending is a feasible and fast source of income, easily adapting to the space, time and to the product demands of the population. This flexibility benefits not only vendors but also buyers, offering them faster and more convenient access to affordable goods (De Santibañez, 2017). Street vendors contribute not only to commercial activity, they also play a crucial role in the social life of public spaces. They create lively urban environments that accommodate diverse users, from different backgrounds, promoting interactions, a reduction in class boundaries (Isha & Pratap, 2023) and acting as stimulants for community cohesion (Torky & Heath, 2021).

Despite its advantages, street vending has been a suppressed and restricted practice by authorities since colonial times (Rivasplata Varillas, 2024). As an informal activity, street vending operates outside formal regulatory systems, possibly leading not only to economic disadvantages such as tax evasion, unfair competition, and the sale of low-quality products, but also to negative impacts on public space (Zhang & Shao, 2024).
The use of public space by street vendors is typically based not on a regulatory framework but on the social legitimization of informality. This implicit legitimacy grants street vendors access to public space and the use of urban infrastructure. (Diaz Guevara & Quito Torres, 2022). This unregulated occupation and use of the public space can lead to mobility challenges, including pedestrian and vehicular congestion (Damanik, 2022), as well as environmental issues such as solid waste contamination, noise pollution and visual contamination (Isha & Pratap, 2023). Additionally, the agglomeration of large crowds in narrow streets can foster perception of insecurity. As a result, street vendors are often perceived as a threat to the quality of public space, contributing to the degradation of the city's image through disorder, unpleasant odors, waste accumulation, and vandalism (Arisha & El-Moneim, 2019).
Given the negative impacts on the urban environment often associated with street vending, authorities worldwide seek to regulate it. However, generally the proposed solutions don´t seem to be successful. In Lima, the continued expansion of street vending, despite its prohibition since colonial times, remains a persistent issue for the

municipalities, highlighting the authorities' inability to effectively control or manage this informal activity (Rivasplata Varillas, 2024).

The most common solution to the problem of street vending and urban space, both in Lima and globally, is relocation. This strategy involves the moving of street vendors from the streets or other public spaces, to commercial clusters such as markets, fairs and other concentrated locations (De Santibañez, 2017). This strategy, nevertheless, has rarely been successful. In Lima, the only successful recognized case is “Polvos Azules” (Córdova Távori, 2021). In areas, such as the study site of this research, in recent years, there have been at least two attempts at relocations, both of which failed, having the street vendors back to their original vending locations in the streets.
The main reasons for these failures are: (1) Poorly chosen relocation sites. These are often in unattractive, peripheral, lacking of proper infrastructure (Ruiz Miranda, 2023), and neglected areas of the city. These locations typically suffer from low accessibility and limited pedestrian traffic (Baroni, 2007), which directly impacts the sales and income of vendors, who typically rely on their daily earnings to sustain themselves. (2) The costs for their movement and rents that they can´t afford. (3) The lack of space for all vendors in a single concentrated place. (4) The lack of street vendors ‘participation (WIEGO) and absence of studies on their dynamics in the planning of solutions. This often leads to disregarding important characteristics of their business and locations, such as the flexibility, autonomy, their relationship with frequent customers (Widjajanti & Wahyono, Space Livability of Street Vendors in Simpang Lima Public Space, Semarang, 2018), and the reciprocal interactions with formal shops selling complementary products.

Recognizing that street vendors play a crucial role in the economy and urban social life, while also acknowledging the urban degradation caused by their unregulated activities, and considering the limitations of the relocation strategy as a solution (Weesinghe, 2022), there is a need for a different approach.
As Hernando de Soto (2000) suggested in *The Mystery of Capital*, the solution to informality lies in integrating its dynamics within a regulatory framework. In the case of street vending, this could mean reorganizing vendors within their original location. Maintaining a balance between the economic needs and the respect for qualities that are inherent to public spaces is essential to achieve urban integration (García Domenech, 2015) .

To ensure the quality of the urban environment, while meeting the socio-economic needs of street vendors, it is crucial for urban planner and designers to develop contextually responsive and spatially informed interventions (Peimani & Kamalipour, 2024). Achieving the successful integration of street vending into public space requires an understanding of the relationship between vendors' spatial organization and the built environment. In studying this relationship, research has often prioritized street vending as the primary subject, analyzing its impacts on public space while relegating the built environment to a passive role (Zhang & Shao, 2024).

1.2. Research question and hypothesis

This research aims to understand the influence of the built environment on the spatial behavior patterns of street vending in the study site of Mercado Central and Mesa Redonda in the Historic Center of Lima, through computational and qualitative analysis, focusing on variables of the street scale.
Below, the main question for the research and its correspondent hypothesis are presented.

Which characteristics of the built environment at the street scale influence street vending spatial behavior patterns in the study area, and in what ways and to what extent they do so?

H1: Street vendors tend to be more densely located in pedestrian-only streets, while they avoid streets prioritizing motorized-vehicles.

H2: Street vendors tend to be more densely located on streets or side of the street with a higher concentration of retail entrances.

H3: While pavement width does not significantly influence street vendors´ location choice, street vendors are more likely to occupy wider pavements.

H4: Street vendors tend to be more densely located in areas with opportunity space, and as the area of opportunity space in a street increase, vendors tend to occupy less of the pavement.

H5: Street vendors tend to be more densely located in highly visible areas.

1.3. Research aims and goals

The primary aim of this research is to examine how the built environment influences the spatial behavior patterns of street vendors, providing valuable insights to guide urban planners and managers in the spatial reorganization and integration of street vendors within the area of Mercado Central / Mesa Redonda in the Historic Center of Lima. The main research goals are as follows:

1) **Identify possible variables from the built environment that influence the spatial behavior patterns of street vending, for which the following steps will be implemented**

    - Identify variables studied in previous literature.
    - Evaluate the relevance of the variables extracted from literature review through expert consultation and on-site observations.
    - Select the most relevant variables

2) **Understand how and to what extent the selected built environment variables influence the spatial behavior patterns of street vending.**

   - Conduct quantitative analysis through computational and statistical analysis to find the correlations between street spatial behavior patterns and the selected built environment factors.
   - Conduct qualitative analysis through interviews and site observations that corroborate findings and gain a deeper understanding of the quantitative findings.

1.4. Significance of the study

Understanding the spatial behavior patterns of street vendors in relation to the built environment is a crucial step for urban designers, planners, and managers in developing more inclusive cities and public spaces, while also improving the quality of urban environments in developing regions such as Peru.

In the historic center of Lima, this study is particularly relevant due to the deeply rooted presence of street vending and the ongoing struggle of the municipality to regulate it. Moreover, with the upcoming implementation of the official urban plan, *Plan Maestro del Centro Histórico al 2029 con Visión al 2035* (Master Plan for the Historic Center of Lima to 2029 with Vision to 2035), which largely overlooks street vending in its guidelines and strategies, this research also serves as a call for greater recognition and consideration of this essential urban dynamic.

This study also contributes to the limited research on the spatial integration of street vendors in the urban environment, as most existing studies focus on the social, economic and political aspects of street vending (Widjajanti & Damayanti, 2020). Furthermore, this research shifts the focus to the built environment, addressing a research gap globally and specially in the context of Peru, given studies usually focus on the impacts of street vending on urban spaces (Zhang & Shao, 2024) .

This study also develops a research framework that integrates quantitative and qualitative methods, combining computational analysis, interviews, and on-site observations. This comprehensive approach provides a foundation for assessing street vending in other areas of the city. Additionally, the data gathered in this research on street vending (classification, counting and mapping), in the Historic Center of Lima could serve as a resource for research in related fields.

1.5. Thesis structure

This thesis is structured into six chapters, with the aim of gaining a deeper understanding of street vending and its relationship with the built environment, and to develop a framework for analyzing this relationship.

Chapter 1 introduces the research topic by examining the perception of street vending as a problematic practice in public spaces. Then it describes the necessity for alternative approaches, given the failures of relocation strategies, and emphasizes the importance of studying not only how street vending affects the urban environment but also how the urban environment impacts street vending. Furthermore, this section presents the main research question, goals and the significance of the study.

Chapter 2 reviews existing research on street vending and the built environment. It presents general definitions for street vending activity, street vending spatial behavior, and the most important section describes previous studies on the characteristics of the urban built environment that influence street vendors' spatial behavior.

Chapter 3 introduces the Mercado Central/Mesa Redonda area in Lima's Historic Center as the study site. It describes street vending in Lima, particularly in the historic center, and examines the impacts and consequences of the regulatory framework on these practices.

Chapter 4 outlines the combined qualitative and quantitative methodology employed in this research. It consists of four sections: data collection on street vending; the selection process for built environment variables affecting street vending spatial behavior, along with their data collection and analysis; and the on-site interview process and its findings.

Chapter 5 presents the results and discusses the findings for each analyzed variable concerning street vendors' spatial behavior, integrating both quantitative and qualitative analyses.

Chapter 6 presents the summarized key findings and explains the limitations and potential directions for future research.

2. Literature review

2.1. Introduction to street vending

Street vending is a phenomenon that can be observed predominantly in the urban areas of developing countries, although it also exists in developed nations. A street vendor is a person that offers goods or a service in the public space, such as streets, roads, pavements, squares and parks, using simple non-permanent or movable setups (Fanggidae, 2021).

Street vendors can be classified based on key characteristics:

- **Type of offer:** street vendors offer a wide range of goods (including food, articles, ware, merchandise, etc.) or services (Baroni, 2007; Linares, 2017)
- **Mobility and structures used:** street vendors can use stationary, semi-stationary or movable setups, such as kiosks, mats, tents, pushcarts and baskets (Fanggidae, 2021).
- **Legal status:** street vendors can be formalized with a legal permission to occupy a space or they can be informal operating without official permission and facing the risk of eviction by municipal authorities (Diaz Guevara & Quito Torres, 2022).
- **Urban location:** street vendors can be located in central and commercial areas, where they have access to a large number of customers, but face greater competition. Or, alternatively they could operate in less accessible areas selling specialized products (Baroni, 2007).

Street vending can be analyzed through many disciplinary perspectives. Although social science is the predominant discipline in the study of this phenomenon, significant research has also been conducted within the fields of urban planning and environmental psychology. (Fanggidae, 2021). These fields usually focus their studies on the regulatory frameworks, the perception of street vendors as an urban element, the spatial configuration of street vending, the impacts of street vending in the built environment and urban sustainability, and, most relevant to this research, the **spatial behavior patterns of street vending.** The latter examines how the urban environment´s physical and social characteristics influence street vendors spatial patterns.

These last two perspectives reveal a fundamental dilemma of street vendors in the public space: one approach seeks to solve the problems caused by informal commercial activities in the urban space, and the other aims to solve the problems experienced by street vendors in the urban space.
In the Peruvian context, where this issue is particularly strong, existing research has predominantly focus on the first approach. While it is important to acknowledge the negative impacts of street vending, it is equally important to recognize that the ability of street vendors to survive in physical limitations, without legal support and planning, is a rare and valuable quality that deserves closer attention and understanding (Fanggidae, 2021).
Furthermore, achieving sustainability in the urban environment in developing nations, goes beyond addressing the environmental issues caused by street vending.

Sustainability also includes economic and equity concerns. Given that street vendors represent a crucial source of employment and that they facilitate social interactions that reduce class boundaries, it is important to understand their economic and social dynamics within public space to achieve sustainability (Isha & Pratap, 2023). This understanding is essential to be able to integrate them properly.

2.2. Street vendors and their spatial behavior

Previous research has examined the various physical and socio-economic characteristics from urban environment that shape the spatial behavior of street vendors. This section reviews existing studies to highlight the key influences on street vending spatial patterns.

Although **pedestrian flows** or concentration of potential customers are often assumed to have the strongest influence on street vending, this correlation is not well established in the literature (Peimani & Kamalipour, 2024). However, studies conducted in various contexts have demonstrated a crucial relationship.

Widjajanti and Damayanti (2020) analyzed the space compatibility for street vendors in the Chinatown in Semarang, Indonesia. The quantitative analysis, showed that vendors were predominantly located along roads with high pedestrian traffic. These findings were further supported by interviews, where 92.2% of respondents declared that they selected their locations based on the high number of visitors.
Peimani and Kamalipour (2024) demonstrated in their studies on Tehran, Iran, that street vendors are attracted to areas with high pedestrian flow, such as bus stops, by comparing maps based on pedestrian and street vendor counts.

In Cairo, Egypt, Farouk (2019) examined the areas surrounding transport terminals and, through gate counting, identified a strong correlation between high pedestrian movement and street vendor concentration, with a correlation coefficient of $r = 0.68$. The study also found that main streets, station entrances, metro gateways and markets, where foot traffic is consistently high, also had the highest density of street vendors.
Regarding this, De Santibañez (2017) explains that one of the spatial organizations patterns that street vending follows is the logic of centrality, for which the consumers reach the concentration of street vendors because they choose locations in **proximity to urban nodes**, such as markets, commercial streets, shopping centers, schools, stations, etc.

This is also related to the influence of **land uses**. In their study of the suitability of street vending in the public space, Zhang and Shao (2024) developed a suitability map that showed that street vendors in Wuchang District, will most likely be located in areas with concentration of commercial land uses, because this maximizes their access to costumers. Residential areas and small parks, on the contrary, exhibited a moderate suitability.

Other studies suggest that, given the established associations between **street network spatial configuration** and pedestrian movement, the spatial layout of streets may have a strong influence on the distribution of street vending. Research on this topic has analyzed the centrality of a street network and found better connected and more integrated streets tend to have a higher density of street vendors.

Sun, Scott, Bell, Yang, & Yang (2022) analyzed the relationship between street vending distribution and the street centrality measures integration and choice in the city of Yuncheng, China. The results showed that more than 62% of street vendors, where located in the top 20% streets with the highest values for integration and choice. In Cairo, Farouk (2019) found that the correlations between street vending distribution and choice was moderate with a coefficient of r = 0.4, while for integration a strong correlation was found with r = 0.5.

Profitability is closely tied to a location with access to a high concentration of potential customers. However, other **socio-economic factors** also play a crucial role in determining profitability and, consequently, the distribution patterns of street vendors.

One key factor is the type of product being sold. Certain products generate consistently high profits due to a significant margin between production costs and market value or due to local popularity of the product, reducing the reliance on location for profitability. In contrast, products with standard profit margins often require strategic placement in specific locations to attract customers and ensure financial viability. Furthermore, the level of competition in a location can attract or push back vendors (Baroni, 2007).

Zhang and Shao (2024) mentioned land price as relevant influence for street vendors spatial distribution, particularly for the ones operating in formalized areas where rent is required. High rent costs can affect the operating expenses of street vendors, leading them to look for more affordable locations. Therefore, areas with moderate or lower rental prices could be preferred.

Another considerable variable influencing street vending spatial patterns are **urban management and regulatory frameworks**. Given that street vendors operate in the public space, they are prone to more restrictive regulations than other types of informal commerce
Municipal regulations can designate specific areas in the public space where street vending is allowed or prohibited. Formal vendors must operate within those spaces, directly influencing their distribution in the urban environment (Orellana Etchegaray, 2024). Additionally, the presence of police and municipal authorities can deter vendors from operating in certain areas, even if those locations have commercial advantages. As a result, informal vendors might choose more unregulated and hidden locations (Sun, Scott, Bell, Yang, & Yang, 2022).

In addition to pedestrian flows, street network configuration, land use and the proximity to urban nodes, which define key aspects of the urban environment in a city-scale, previous research also highlights street-scale **elements and characteristics of the built environment** that can influence the spatial behavior of vendors. While pedestrian movement is the major driver for street vending distribution, studies have shown that it is not the only determining factor and thus, the urban environment requires a more detailed examination (Zhang & Shao, 2024)

Understanding the influence of these physical elements is essential to plan vibrant urban environments that can effectively accommodate street vending (Weesinghe, 2022).
Furthermore, studies on successful vendors ordering plans, highlight the necessity to understand the spatial patterns of street vending, to be able to provide specific locations for each vendor, and a spatial design that considers the spatial-temporal varieties of every type of vendor and their use of the public space (Ojeda & Pino, 2019).

2.3. The built environment and street vending spatial behavior

The built environment includes every place and space build and modified by humans to fulfill his needs and requirements. In the contact of urban planning, it refers to all physical elements that make a city including structures, parks, streets, etc. (McClure & Bartuska, 2007). The literature assessing the examining the influence of the built environment on street vending spatial behavior is relatively limited, particularly in regards to street-scale elements and its characteristics. Nevertheless, this section will provide a review of studies that examine the relationships found between these smaller-scale elements and characteristics of the built environment with street vending spatial behavior,

Street typology

Street typology is an influential variable in street vending distribution. Main streets with high pedestrian movement could exhibit a higher concentration of street vendors (Sun, Scott, Bell, Yang, & Yang, 2022). Swai (2019), observed how certain shared streets in Dar es Salaam city centre (Tanzania) were purposely intervened to make them more pedestrian and street vending friendly. Some roads were elevated and flower pots are put in the edges to alert cars.
Although the presence of cars generally is not preferred, in certain areas of the city, such as terminals, vendors benefit economically from selling to drivers. Therefore, they would also be located in streets with high vehicular traffic (Farouk, 2019).

Functional mix

As mentioned in the previous section, land use plays a significant role in shaping the distribution of street vending at the city scale. Peimani and Kamalipour (2024) examined how the synergies between different functions (work, live and visit), in a street and block, or the functional mix, influence the spatial distribution of street vendors. Their findings exhibited that streets with diverse functional mix had the highest concentration of street vendors, particularly the areas intersecting work and visit. In contrast, monofunctional residential or work areas had little to no street vending. This was attributed, according to observations, to the fact that areas with a high mix of functions, attract more pedestrian movement. Another study in Valdora (India), also found that vendor´s spatial distribution in terms of number, typology and magnitude is linked to the patterns of functional mix (Dalwadi, 2010).
Widjajanti, Sunarti, and Ardiati (2020) also observed that in Semarang’s Chinatown (Indonesia), street vendors contributed to the functional mix by complementing the area's primary land uses with their economic activities. For example, street food vendors were

commonly found in work areas, enhancing the existing urban functions and catering to the needs of workers and visitors.

Retail edges

Regarding urban functions, Peimani and Kamalipour (2024), also studied the relationship between street vending and retail edges in Tehran. Retail edges refer to the effect of storefront entrances and window displays in pedestrian activity, drawing people toward the street edges. Their analysis, which compared maps of street vendor locations with retail storefront distribution, revealed that the highest concentration of street vendors was found on streets with a greater density of storefronts
Empirical evidence also suggested a reciprocal relationship between groundfloor storefronts, pedestrians and street vendors in relation to the attraction of customers.

The edge effect in relation with street vendors is further explained by Jwalant, Urvashi and Mayuresh (2024). They described how the **length of frontage plots** influences street vending. Longer distances between entry/exit points reduce the opportunities for street vendors to engage with customers. In the contrary, the shorter the the distances between entry/exit points, the greater the opportunity to enage with customers (see figure 1).

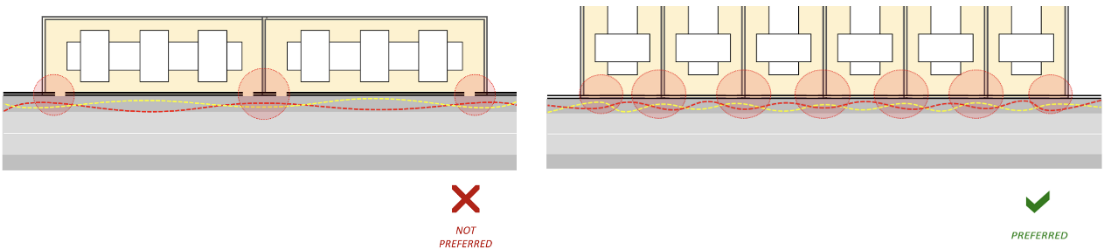


Figure 1: Length of frontage plot influencing pedestrian behavior. Source: (Jwalant, Urvashi, & Mayuresh, 2024)

Although the correlation between storefronts and street vending tends to be high. Liu (2020) showed that in central Manhattan (New York) there are no co-clustering effects among street vendors and formal retailers belonging to the same category.

Visibility

Another important characteristic of the built environment, when it comes to sales opportunities is visibility. Visibility examines the relationship between urban space morphology and the visual experiential qualities perceived by users (Koltsova, Tunçer, & Schmitt, 2013). It could be a significant influential characteristic since the way a space is structured can impact how easily vendors can be seen by potential customers (Zhang & Shao, 2024).

In their study for suitable space for street vendors, Zhang & Shao (2024) found through literature review and policy documents consultation that a space with high visibility is suitable for vendors. This is not only for the commercial advantages, but also because high visibility is usually related to **spatial openness**, which is good for air circulation and noise difussion. For the analysis of spatial openness he used the skyliine tool.

Swai (2019) studied the different concentrations of food-street vendors in straight streets and street junctions, which tend to have a higher visibility. The findings showed that junctions have higher chances of getting more customers, which attracts more street vendors. Nevertheless, some customers also claimed that they take food and drinks along the street because they like to watch people walking. He furthered analyzed the number of vendors per junction type, finding that T-juntions, X-junctions and multiple junction hold the highest concentration of street vending.

Despite the importance of a highly visible location, a street vendor's exposure to customers also depends on their ability to advertise goods and services, whether verbally or visually. Additionally, while a location with high visibility can attract more customers, it also increases the risk of detection by authorities, potentially leading to eviction (Peimani & Kamalipour, 2024).

Pavement width

Pavement walkability is a crucial requirement for street vendor facility areas, as sufficient walking width can provide more operating space for street vendors and ensures a smooth and safe walking experience for pedestrians (Zhang & Shao, 2024).

While no studies reviewed in the literature demonstrated a direct influence of the pavement width in the density distribution of street vendors, possibly because they adapt to the existing conditions, empirical studies highlight the intricate relationship between street vendors, pedestrians and sidewalks.
Hagos, Adnan and Yasar´s (2020) conducted a study in Addis Ababa (Ethiopia) revealing that the average pedestrian density varies in response to pavement width and the occupation area of street vendors. Their findings concluded that the presence of vending activity in sidewalk, reducing the space in the pavement, increases the pedestrian congestion, which in some cases can result in pedestrians evading certain streets.
Other studies describe an organically harmonious relationship between pedestrians, street vending, and pavement width. Swai (2019) observes that in the city center of Dar es Salaam (Tanzania), pedestrians and street vendors coexist smoothly, as vendors tend to position themselves in ways that do not obstruct pedestrian movement. This balance is likely facilitated by the 3-meter-wide sidewalks, where vendors typically occupy 1 meter, leaving 2 meters for foot traffic, allowing for an efficient shared use of space.

Given these findings it is more likely that the pedestrian width affects not the density distribution of street vendors, but their occupation of pavements.

Parking lanes

Jwalant, Urvashi, and Mayuresh (2024) identify the width of parking spaces as a relevant morphological characteristic influencing street vendor locations. They highlight the potential use of these spaces as extensions or operating areas for vendors, making them particularly attractive.

Similarly, Swai (2019) notes that in the city center of Dar es Salaam (Tanzania) proximity to parking spaces benefits street vendors by allowing customers to park nearby, especially at night when it becomes unsafe. In this context, straight streets become more favorable for vending than street junctions, as they offer better access for drivers.

Other built environment elements are mentioned in the literature; while not directly influencing the spatial behavior of street vendors, they can affect their working conditions. These include **shade** provided by canopy tree cover and **greenery**, as well as the **distribution of streetlights**.

Jwalant, Urvashi, and Mayuresh (2024) identified the size and distribution of canopy tree cover as a characteristic of the urban environment affecting street vending comfort. Furthermore other study observed that the proximity to trees served as a protective barrier between customers and vendors, and vehicular traffic on shared roads (Swai, 2019). Zhang and Shao (2024) highlight the importance of optimal greening rates in creating suitable spaces for street vending. They argue that greenery improves air quality and enhances working conditions, which has become especially relevant in the post-COVID-19 era.

As shown in table 1, which summarizes the variables identified as characteristics from the urban and built environment influencing street vending spatial behavior and working conditions, previous research uses a variety of methodologies. These methodologies range from qualitative to quantitative approaches, including site-observations, semi structured interviews, surveys, systematic literature review, ethnographic studies, cartography and mapping, and computational and statistical analysis.

Table 1: Literature review summary for variables from the urban and built environment influencing street vending

Source	Study site	Main aim of the study	Methodologies for evaluation	Variables
(Widjajanti & Wahyono, 2018)	Chinatown, Semarang city (Indonesia)	Identify space compatibility based on the spatial behavior of street vendors at their activity's location.	Descriptive quantitative method with questionnaires and Geographic Information System (GIS).	Activity Accumulation and flow of visitors
(Zhang & Shao, 2024)	Wuchang, Wuhan (China)	Study and evaluate the suitability of street vending within Wuchang District of Wuhan, China.	Constructing an indicator system based on a policy and literature review, and a spatial quantitative analysis via GIS	Spatial openness Commercial agglomeration Land price Crowd density Pavement walkability Traffic accessibility Visibility
(Deore & Lathia, 2019)	Ahmedabad (India)	Understand the role of street vendors in Ahmedabad's urban fabric	Extensive spatial analysis of 4,000 vendors at four different time points of the day, perception studies of their clientele disaggregated by gender, income and age, and their relationship with surrounding land-use and street.	Street hierarchy Sidewalks Canopy tree cover
(Peimani & Kamalipour, 2024)	Saadi, Tehran, (Iran)	Understanding how street vendors conduct their business in relation to human/non-human entities.	Observation, fieldwork notes, photography, archival records, and urban mapping,	Functional mix Retail edges Pedestrian flows
(Liu, 2020)	Central Manhattan, New York (USA)	Explores the spatial patterns of street vendors and the spatial relationship between formal retailers in the central part of Manhattan	Geospatial statistic methods including Location Quotient, M-function and kernel density analysis.	Formal retailers' locations
(Farouk, 2019)	Cairo (Egypt)	Understand if the spatial distribution of street vendors in terminal stations is influenced by the spatial configuration and other variables of the built environment, or by pedestrian movements.	Space syntax analysis for choice and integration measures and on-site observations and counting for pedestrian movement patterns. In addition, a statistical analysis was performed by implementing the Statistical Package for Social Sciences.	Area's type Proximity to metro and railway stations Proximity to terminal entrance Street length (meters) Traffic density (choice and integration)
(Swai, 2019)	Dar es Salaam city Center (Tanzania)	Determine the dynamics of food-street vending in Dar es Salaam as an avenue for commercial opportunity, urban vibrancy and space creation.	Overall mapping of all the street food-street vending. For data collection, questionnaires were administered and interviews were conducted. Moreover, physical measurements, sketching and photographing were taken to facilitate the study.	Pavement width Visibility Parking lanes Pedestrian priority Trees
(Jwalant, Urvashi, & Mayuresh, 2024)	Mumbai, India	Understand the reciprocal relationship between street vending activities and public spaces in metropolitan areas such as Mumbai	Examining existing policies and legislation that govern street vending, available scholarly literature, and established theoretical concepts to develop a matrix of evaluation. This is applied to various areas of the city where street vending is prevalent to obtain and analyze tangible and measurable data.	Width of sidewalk Width of parking lane or carriage lane Height and spread of street lights Length of frontage plots Distance between trees and canopy size

2.4. Literature Gaps

Although there is significant research on the relationship between the built environment and spatial behavior of street vending, much of the focus remains on how street vending impacts the built environment. However, relatively few studies explore the reverse relationship, how does built environment influences street vending spatial patterns.

Moreover, most studies on have been conducted in the African and Asian contexts, as shown in table 1. There is a notable gap in research focusing in the Latin American context, where informality plays a crucial role in both the economy and the urban public space. Given the importance of street vending in Latin America, further research is needed to understand how this informal activity can be successfully integrated into the public space.

When examining the scale of studies addressing this topic, most research focuses on understanding street vending spatial behavior in relation to city-scale variables, such as land use patterns, street network configuration, and pedestrian movement. However, fewer studies investigate the influence of street-scale variables, such as pavement width, storefront density, and shade, which affect vendor´s day to day operations and interactions. These studies are necessary for urban planners to gain a more detailed understanding of street vending dynamics and to develop comprehensive strategies for its successful integration into public space.

Furthermore, studies on street-scale variables predominantly rely on observational and qualitative methods. While these methodologies are appropriate to capture the nuances of the street vending, complementary computational analysis could also improve our understanding of general patterns by analyzing large datasets. Additionally, computational analysis could provide a solid foundation for the qualitative research, allowing for a more comprehensive approach.

This research aims to address these gaps by analyzing the influence of street-scale variables in the built environment on street vendors' spatial behavior in Lima, Peru, using a combined qualitative and quantitative approach. By doing so, it will provide data-driven and detailed insights that can inform urban planning decisions, particularly when developing strategies for the reorganization and integration of street vendors into public space.

3. Case study: Mercado Central, Mesa Redonda

The research focuses in a case study that comprises the surrounding areas to the Mercado Central and Mesa Redonda markets, located in the Historic Center of Lima. This section presents a brief introduction into street vending in Lima and then dive into a description of the study area including the street vending regulatory frameworks.

3.1. Street vending in Lima

Street vending in Lima has its roots in colonial times. It started approximately around the end of the 16th century, with mostly impoverished Spaniards that sold items in streets that they bought from other traders (Rivasplata Varillas, 2024). Although this practice was limited and in cases restricted by the authorities throughout the centuries, it was socially institutionalized with vendors specializing by products.

The 20th century brought a great increase in the internal migration into the capital. The lack of formal employment opportunities for the migrants, and the general increase of the urban population, expanded the practice of informal commercial activities, which covered the employment deficit and the commercial demand (Villantoy Gómez, 2023). In the 80´s, under the guidance of the major Eduardo Orrego, one of the most problematic areas because of the high concentration of street vendors, was cleared after a successful relocation into an esplanade which constituted the fair “Polvos Azules”.

Along the years, municipality authorities of different district in Lima have implemented actions to clear the streets occupied by street vendors, such as evictions and relocations, however, informal commercial activities persist (Silva, 2025). In recent years, Lima has experienced an increase in this practice, primarily due to external migration coming from Venezuela and the economic crisis caused by the Covid-19 pandemic (Rivasplata Varillas, 2024).

There are three specific areas of the city which have the highest concentrations of street vending: Gamarra in the district of La Victoria, Las Malvinas in the district of Cercado de Lima, and the Historic Center of Lima, which is the area of study of this research.

3.2. The study area: Mercado Central / Mesa Redonda

Since the emergence of street vending in the city, the Historic Center of Lima has been a key area for its concentration. During colonial times, the main square served as the primary hub for street vendors (Silva, 2025).
With the city's expansion in the 19th century, the Historic Center was gradually abandoned as a residential area and transformed into a predominantly commercial district. This shift led to an increase in commercial activity, attracting both formal businesses and informal vendors.

Currently street vendors are scattered throughout the historic district, with one particular sector becoming the focal point of ongoing disputes with the municipality: the neighborhoods of Mercado Central and Mesa Redonda (see figure 2), which will be the focus of this research. The names of these neighborhoods are derived from the presence of the Central Market Ramón Castilla and the Mesa Redonda commercial emporium.

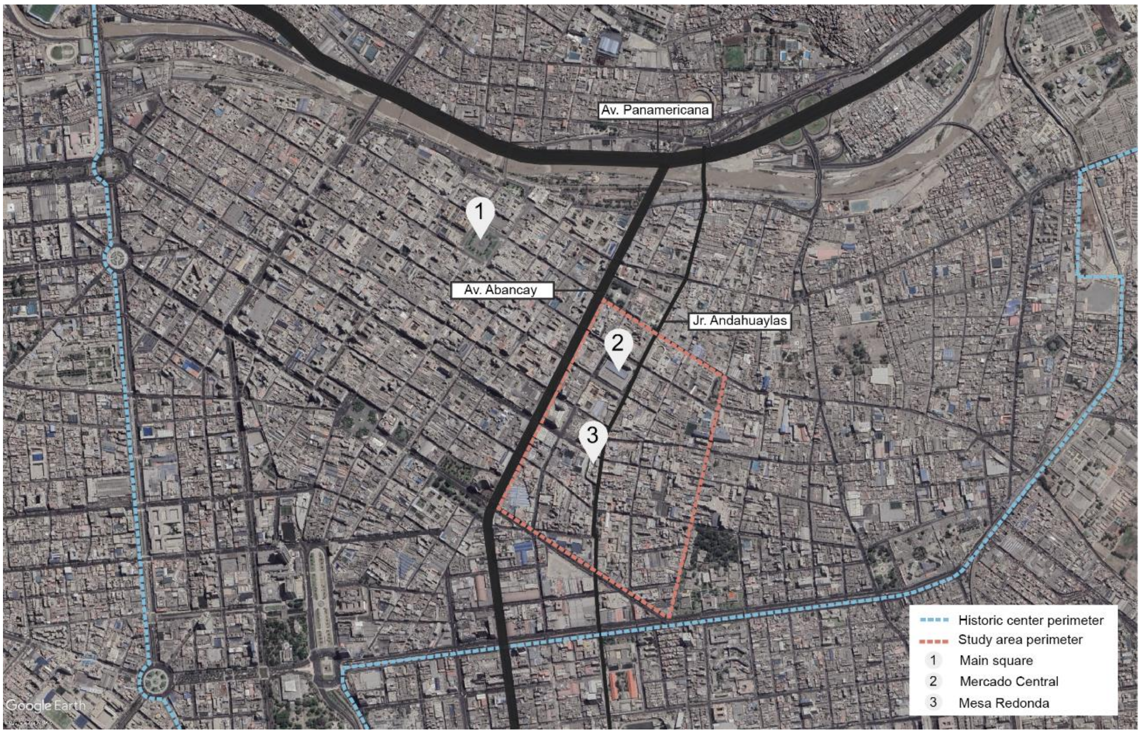


Figure 2: Satellite image of the study area within the Historic Center of Lima

The Mesa Redonda commercial emporium officially opened in the mid-1980s and serves as a hub for both wholesale and retail commerce, offering a wide variety of products, especially those related to seasonal festivities.
The Mercado Central Ramón Castilla is the city´s first and one of its largest markets. It was originally built in the 19th century, to meet the commercial demands of the urban expansion. However, the current infrastructure was built in 1967. The market offers a diverse range of products, including meat, fish and seafood, fruits, vegetables, groceries, footwear, and bazaar items (Angulo, 2012).

Due to the presence of these two important commercial hubs and a variety of surrounding retail shops, this sector of the historic center attracts approximately 300,000 visitors per day (Batalla, 2025). Therefore, attracting around 6000 to 8000 street vendors (Mc Cubbin, 2023), further intensifying commercial activity.

The study area is defined by the polygon encompassing all the blocks and roads within the perimeter formed by av. Abancay, av. Nicolás de Piérola, jr. Huanta, and jr. Junín, as seen in figure 3.

Figure 3: Study site map based on a drone imagery.

Access to the site in predominantly give through av. Abancay, which is a major arterial road that connects the historic center with its adjacent districts and with the main national highway, Av. Panamericana, to the north along the Rimac River. Furthermore, av. Abancay serves as a key public transportation corridor, with one formal bus line and several informal transport services operating along the avenue, giving access to the study site. On the other hand, jr. Andahuaylas is the main and most crowded street of study area given that it connects the two commercial hubs. Additionally, this street leads to one of the few only-pedestrian bridges that go across the river to the neighboring district of El Rimac.

The Mercado Central and Mesa Redonda neighborhoods, are predominantly commercial, hosting a wide variety of businesses. However, it also includes mixed-use and residential areas, along with educational institutions, government offices, churches and parks. The residential areas are mostly concentrated in the blocks to the east of Jr. Paruro (see figure 4a).

As mentioned earlier, the commercial nature of the site attracts thousands of visitors, resulting in high pedestrian traffic throughout the area. Only in the eastern side, where commercial activity decreases, the streets exhibit low pedestrian movement (see figure 4d). This high volume of people in the public space contributes to the general perception of safety in the Mercado Central and Mesa Redonda neighborhood, in term of crime presence. However, at night, when commercial activity is lower, the perception of insecurity increases (see figure 4c).

Figure 4: Study site analysis maps. a) existing land uses, b) type of commercial activities, c) perception of insecurity, d) pedestrian flows. Source: Plan Maestro del Centro Histórico de al 2029 con Visión al 2035.

3.3. Regulatory framework on street vending

In Peru, street vending as a legitimate economic activity is supported by Articles 2 and 3 of the National Constitution and the Supreme Decree No. 005-91-TR. However, there are no specific regulations addressing this sector. Instead, street vending activities are usually regulated by local ordinances at the district municipal level (WIEGO).

The study area polygon, as part of the Historic Center, is regulated by the Lima Metropolitan Municipality. Over the years, the municipality has issued and abolish various ordinances concerning street vending.
Ordinance N° 062, published in 1994, promoted the gradual eradication of commercial activities in the streets of the Historic Center. Under this regulation, the main squares and public spaces were cleared from street vendors. In 2014, the Ordinance N° 1787 established that, under the appropriate regulations, street vending could be authorized if it met the adequate conditions in the public space, highlighting respect for order, security, cleanliness and aesthetics (Perez Herrera, 2018). Although this was the first regulation addressing the spatial conditions for street vending, it was later repealed after the change of government.

In this context, in the recent years, Mercado Central and Mesa Redonda sectors have been the focus of municipal restrictions, evictions and relocations with the aim to reduce street vending in the area, particularly during festive times, when the high concentration of vendors greatly impacts mobility and security. Despite these measures, street vending has not decreased, as it is a phenomenon deeply rooted in the national economy (Silva, 2025). While efforts have been made to formalize their activities, the preparation of official guidelines or plans for their use of public space and integration to the urban environment have been overlooked.

The most recent relocation attempt took place in 2023. The Municipal Decree N° 010 designated all roads within the study area perimeter as restricted zones for street vending activities. The authorities gave street vendors in the area a limited time to register their activities, so that they could be relocated to commercial cluster site, which would be known as La Huerta Encontrada market fair.
After the measure was implemented and street vendors were moved to the new location, complaints about the area´s inaccessible, lack of safety and low pedestrian traffic led vendors to return to Mercado Central and Mesa Redonda after just two months (Medrano Marin, 2023).

On the other hand, the *Plan Maestro del Centro Histórico al 2029 con Visión al 2035* (Master Plan for the Historic Center of Lima to 2029 with Vision to 2035) developed by the Planning, Management and Recovery Office of the Historic Center of Lima (PROLIMA), includes an ornamentation guide for the authorized activities in public spaces. This document stablishes the following guidelines concerning street vending in the public space for the future implementation:

- Commercial activities on the street must be conducted using modules provided by the municipality, which have a specific design that must not be altered.

- Modules must leave a minimum pedestrian pathway of 1.20 meters on the pavement and should not obstruct drivers' visibility, access points, facade ornaments, or private property windows.
- Modules should be aligned with existing urban furniture, such as benches, lighting, trees, and gardens.
- If aligned with urban furniture, modules will only be authorized on sidewalks that are between 3.00 and 3.40 meters wide (see figure 5).
- If aligned with the property line, modules will only be authorized on sidewalks that are between 2.00 and 2.40 meters wide (see figure 5).
- A maximum of four modules is allowed per block.

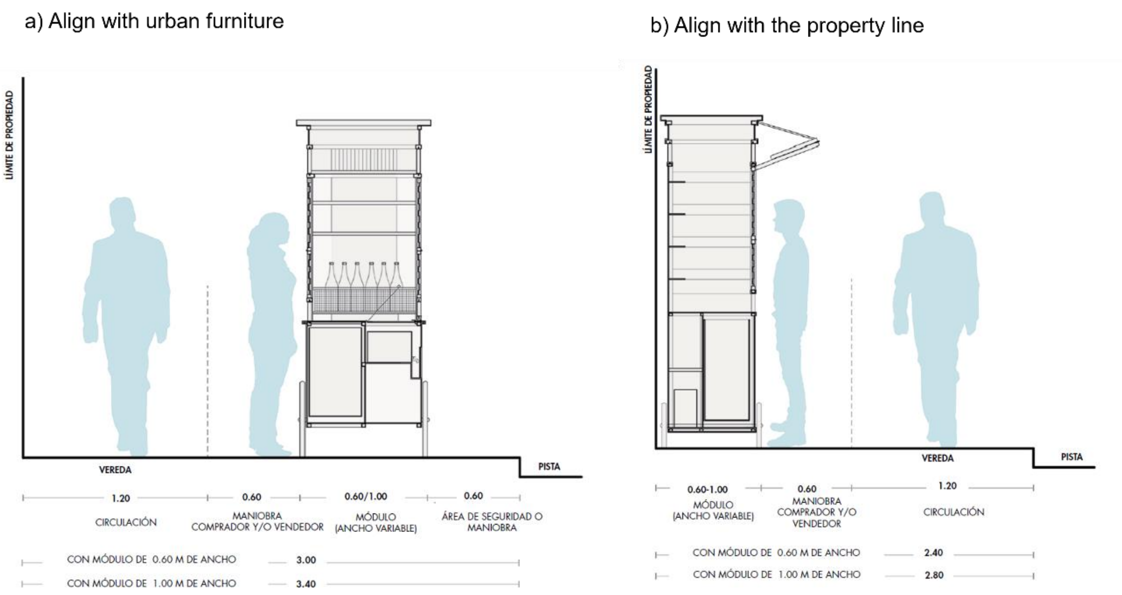


Figure 5: Type of street vending modules. Source: Plan Maestro del Centro Histórico de al 2029 con Visión al 2035.

Although these guidelines aim to restore and preserve the historical aesthetics and order of the public space, they fail to consider the increasing number and diversity of street vendors that currently operate in the study area. The required sidewalk widths do not align with the actual spatial conditions of the site, making the implementation of these regulations unfeasible. Moreover, they do not stablish location criteria based on the type of products sold or the time of the day, which is important to organize a large number of street vendors in a limited area.

While these guide focuses on adapting vendors to the current conditions of the public space, they lack considerations for adapting public space to accommodate them.

4. Research methodology

This research uses a mixed-method approach, integrating quantitative and qualitative analyses to investigate how the built environment affects the spatial behavioral patterns of street vending in the Mercado Central-Mesa Redonda areas of Lima's Historic Center. The study measures and examines the relationships between the distribution patterns of street vending and selected built environment characteristics at a street scale through computational analysis, observations and interviews.

To conduct this research, a digital model of the study area was developed. The datasets on street vending locations and the key built environment variables were incorporated. These variables (street type, pavement width, visibility area, retail entrance density, and opportunity space area) were selected through a cross-referencing of literature review, expert consultations, and on-site observations. Data for these variables was collected using a variety of methods explained in this section.

The correlations between street vending density distribution and these variables were analyzed using statistical methods. Based on this computational analysis, a more detailed observations were conducted for each variable. This was further complemented with on-site interviews. These were conducted to validate and to further understand the findings from the quantitative approach, therefore gaining deeper insights into the factors influencing street vending distribution.

4.1. Study area 3D digitized model

The digitized 3D model of the study area was developed using Rhino and Grasshopper, incorporating data from multiple sources to ensure accuracy. These sources included spatial data extracted from Geo GPS Peru, high-resolution drone imagery of the site, urban plans and documentation from the *Plan Maestro del Centro Histórico al 2029 con Visión al 2035* (Master Plan for the Historic Center of Lima to 2029 with Vision to 2035) published by PROLIMA, as well as satellite imagery from Google Maps.

The model represents key urban elements, including the street network segments, block polygons, building footprints extruded to their respective heights, public space surfaces and pavement areas (see figure 6)

Figure 6: Study area 3D digitized model

Given that this study analyzes built environment variables at a street scale, some of which vary depending on the side of the street, (pavement width, retail entrance density, and opportunity space area) the street network was not modeled as a single centerline representation of roads. Instead, offset street segments were created for each side of the road, allowing for a more detailed analysis that aligns with the study's scale.

Furthermore, during the site visits it was observed that certain streets were definitely restricted to street vending, such as parks, the street in front of the Justice Ministry, and Calle Capón, which is the core of Chinatown. To minimize distortions in the analysis caused by regulatory constraints, these streets were separated and excluded from the analysis (see figure 7).

Figure 7: Study area street network

4.2. Street vending density data collection

Since street vending is largely an informal, temporary, and dynamic economic activity, there is a lack of readily available data on vendor locations both in the study area and in Lima as a whole. No official sources provide an up-to-date, comprehensive mapping of street vending. While the diagnostic section of the *Plan Maestro del Centro Histórico al 2029 con Visión al 2035* (Master Plan for the Historic Center of Lima to 2029 with Vision to 2035) includes a map of street vendor locations in the Historic Center of Lima, this data dates back to 2018 and lacks details such as vendor count and classification by type. This information gap is particularly significant given the substantial role of street vending in the local economy and the prominence of the street vending issue in the municipality's urban management agenda.

For the purposes of this research, street vending includes all commercial activities in public spaces, with the exception of fixed kiosks, which were excluded since they are installed and regulated by the municipality. This distinction was made to focus on vendors operating in more flexible and informal conditions, as their location choices are more influenced by external factors.

Street vending locations fluctuate throughout the day and across different seasons. Nevertheless, due to time and resources limitations, data collection was conducted on a single say and within a specific time frame. The fieldwork took place on Wednesday, September the 18th, between 14:00 and 17:00. This date and time were selected to represent a typical weekday, avoiding holidays or seasonal festivities that could temporarily alter the number, density and spatial distribution of vendors. While this approach provides a representative snapshot of regular street vending activities, it is acknowledged that vendors location patterns may vary at different times of the day or year.

The data was collected on-site by filming with a dash camera, which recorded videos during a car and walking trip covering all the streets within the study area (see figure 8). Based on these recordings and supported by GPS data from the camera, the locations of were manually identified and mapped as points onto the digitized model of the study area in Rhinoceros 3D. Additionally, the collected street vending activities were classified into four categories based on the type of stall or device used.

Figure 8: Images of the video recordings in the study site with a dash camera.

The classification of street vendors was determined based on on-site observations and recorded video footage. Since the study focuses on spatial distribution, vendors were categorized according to the type of stall or device they used. This classification was chosen because it reflects the extent of public space occupation, mobility, and the types of products sold (see table 2).

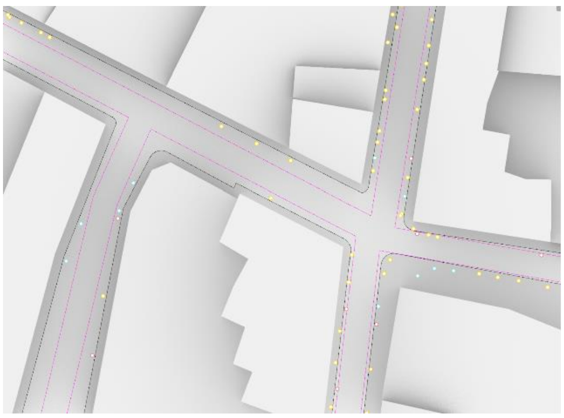
Table 2: Classification of street vendors

Type of street vendor	Products and services offered	Mobility	Equipment and devices	Count
Mobile kiosks	Street food, fruit juices, snacks, watches, and leather repairs.	Semi-stationary	Kiosks and umbrellas.	329
Trolley and tricycles	Snacks, drinks, fruits and vegetables, and bread.	Mobile	Trolleys, tricycles, and umbrellas.	119
Floor mats	Clothing, household items, religious items, crops, and nuts.	Semi-stationary	Cloths or cartons.	106
Tables and hangers	Plastic products, clothing items, household items, household ornaments, electronic accessories, and bags.	Stationary	Boxes, folding tables, stools, mobile hanger, metal grid, plastic containers, etc.	807

Since this research examines the spatial behavior of street vending, this behavior is analyzed through the density distribution of the different types of street vendors across the study area. Density distribution serves as a quantitative measure of vendor concentration along street segments, allowing for the identification of patterns in their spatial organization. By mapping and normalizing vendor density, it is possible to assess how street vending activity varies across the area and to explore potential correlations with built environment characteristics.

$$Street\ vending\ density = \frac{Number\ of\ street\ vendors\ in\ a\ street\ segment}{Street\ segment\ length}$$

Once the data was mapped and classified, the density distribution of street vending was calculated. To assign the number of street vendors to street segments, each street vending point was projected onto the nearest street segment. A 1-meter offset was then created around each segment. The number of street vendors within each buffered segment was counted and normalized per 100 meters to ensure comparability across the study area (see Figure 9).



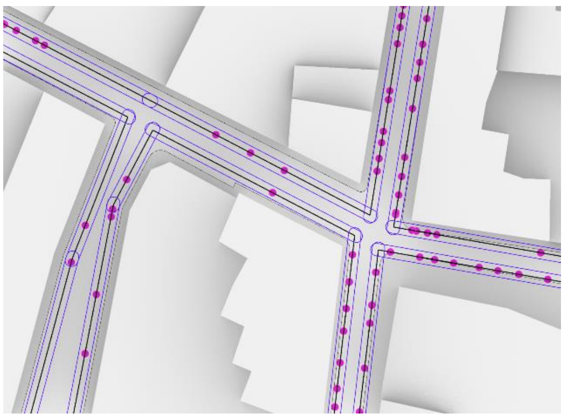


Figure 9: Counting of vendors per street segment

The density distribution of street vending was calculated separately for each vendor type and for the total number of vendors (see figures 10, 11). The heatmaps in Figure visually represent street vending density across the study area, with each street segment color-coded based on vendor concentration. Red indicates the highest density, while blue represents the lowest.

Figure 10: Street vending density per street segment heatmap

The heatmap in figure 10 show and overall concentration of vendors along the main axis, Jr. Andahuaylas, which connects Mercado Central and Mesa Redonda and therefore holds the highest pedestrian traffic. On the other hand, the density of vendors is relatively low in streets to the left, where according to figure 4, has low pedestrian movement and the concentration of commerce is also lower.

The heatmaps across street vending types show different variations as illustrated in figure 11. Most notably, hangers and tables present a similar density pattern to overall street vendors, concentrating in jr. Andahuaylas, while the rest of vendor´s hold high densities of street vendors partially in the main axis and also in other streets.

Figure 11: street vending density heatmaps for each type of vendor

4.3. Built environment variables selection

To analyze how the built environment affects the spatial behavior of street vending in the study area and ensure the relevance of the study, it was first necessary to identify the key built environment characteristics in the street scale that may impact vendors distribution. Three complementary methods were used to select relevant variables. First, a literature review was conducted to extract variables that have been analyzed in previous studies across different contexts. Second, these variables were evaluated and discussed through expert consultation, including interviews and questionnaires, which provided insights into the most relevant factors based on professional experience.

Finally, the selection was verified with on-site observations to identify context-specific dynamics.

Table 3 presents the summary of the variables extracted from the literature review. Most previous studies have examined the relationship between street vendors and the built environment at both the urban and street scales. However, since this research focuses specifically on the street scale, the selected variables within this category include spatial openness, pavement walkability and width, traffic accessibility, visibility, canopy tree cover, functional mix, retail edges, the location of formal retailers, street length, parking or carriage lane width, street lighting distribution, and frontage plot length.

Table 3: Built environment variables summary extracted from the literature review

Source	Study site	Main aim of the study	Studied variables	Definition
(Widjajanti & Wahyono, 2018)	Chinatown, Semarang city (Indonesia)	Identify space compatibility based on the spatial behavior of street vendors at their activity's location.	Activity	*The behavior of street vendors is depended by the various activities in that place (entertainment or recreation, housing, worship, and offices)*
			Accumulation and flow of visitors	*Pedestrian flows*
(Zhang & Shao, 2024)	Wuchang, Wuhan (China)	Study and evaluate the suitability of street vending within Wuchang District of Wuhan, China.	**Spatial openness**	*The degree of enclosure or the perception of space as open or constrained can affect the comfort of street vendors.*
			Commercial agglomeration	*Urban commercial points of interest can attract street vendors.*
			Land price	*Land price can affect the cost of operating a street vendor stall. High land prices may make it difficult for vendors to find affordable locations*
			Crowd density	*Pedestrian flows.*
			Pavement walkability	*Ratio of sidewalk to street width., Sufficient walking width can provide more operating space for street vendors.*
			Traffic accessibility	*Traffic convenience of the street vendor area, which is crucial for customer traffic.*
			Visibility	*Visibility is directly related to the sales opportunities and incomes of street vendors.*
(Deore & Lathia, 2019)	Ahmedabad (India)	Understand the role of street vendors in Ahmedabad's urban fabric	Street hierarchy	*The type of street (arterial, collector and neighborhood) can influence the distribution of street vendors*
			Sidewalks	*Sidewalk width affects the operating space for street vendors and customers.*
			Canopy tree cover	*Trees provide shadow which increases thermal comfort for street vendors.*
(Peimani & Kamalipour, 2024)	Saadi, Tehran, (Iran)	Understanding how street vendors conduct their business in relation to human/non-human entities.	**Functional mix**	*The degree of mixed uses in a block (work, live, visit) can affect the distribution of street vendors*
			Retail edges	*The importance of small-scale storefront entrances and window displays influencing pedestrian engagement and therefore street vendors locations.*
			Pedestrian flows	
(Liu, 2020)	Central Manhattan, New York (USA)	Explores the spatial patterns of street vendors and the spatial relationship between formal retailers in the central part of Manhattan	**Formal retailers' locations**	*Formal retailers attract people and therefore, proximity to their entrances are desirable for street vendors.*
(Farouk, 2019)	Cairo (Egypt)	Understand if the spatial distribution of street vendors in terminal stations is influenced by the spatial configuration and other variables of the built environment, or by pedestrian movements.	Area's type	*The nature of the area (historical, administrative, commercial, rail station) affects the distribution patterns of street vendors.*
			Proximity to metro and railway stations	*The high pedestrian movement around metro or railway stations attract street vendors.*
			Proximity to terminal entrance	*The high pedestrian movement around the entrance to terminals attracts street vendors.*
			Street length (meters)	*Street length affects the operating space for street vendors and the competition for prime spots.*
			Traffic density (choice and integration)	*Pedestrian flows*
(Swai, 2019)	Dar es Salaam city Center (Tanzania)	Determine the dynamics of food-street vending in Dar es Salaam as an avenue for commercial opportunity, urban vibrancy and space creation.	**Pavement width**	*Wider pavement width promotes an organically harmonious use of the space between pedestrians and street vendors.*
			Visibility	*Street vending locations in street junctions attract more customers due to its higher exposure, when compared with straight streets.*
			Parking lanes	*The availability of parking spaces near street vendors is an advantage for their customers that drive.*

			Pedestrian priority	*Street vending thrives is pedestrian-friendly streets.*
			Trees	*Trees act as a protective barrier for street vendors and customers from cars*
(Jwalant, Urvashi, & Mayuresh, 2024)	Mumbai, India	Understand the reciprocal relationship between street vending activities and public spaces in metropolitan areas such as Mumbai	**Width of sidewalk**	*Sidewalk width affects the operating space for street vendors and customers.*
			Width of parking lane or carriage lane	*Parking or carriage lanes increases the operating space for street vendors.*
			Height and spread of street lights	*Street lights distribution affects the perception of security for vendors and customers.*
			Length of frontage plots	*The distances between entry points affects the opportunities for people to interact while walking along the street and this results in opportunities for vendors to attract customers.*
			Distance between trees and canopy size	*Trees provide shade which increases thermal comfort for street vendors.*

Table 4 presents a summary of the variables identified through expert consultation. The process began with individual interviews with 6 Latin American professionals specializing in the subject, who provided insights based on their experience. During these interviews, the variables identified in the literature review were discussed, serving as a foundation for selecting an initial set of built environment variables. Following this, a structured questionnaire was distributed to each expert to further refine the selection by evaluating the degree of influence each variable has on the spatial behavior of street vending.

As shown in table 4, the results from the expert survey exhibit that the variables considered to be the most influential in street vending spatial behavior are pavement width, pedestrian priority of streets, shadow availability, retail entrance density, opportunity space and visibility.

Table 4: Summary of expert consultation on the evaluation of built environment variables.

Built environment variables	**Expert evaluation**						**Average rating of the influence of built environment variables in street vending spatial behavior**
	Expert 01 *Urban consultant for the Municipality of Lima and associate professor at the Pontífice Universidad Católica del Perú*	**Expert 02: Arch.** *Urban consultant for the Development Bank of Latin America and the Caribbean and head of the urban observatory Impostergable*	**Expert 03** *Master of Urban Planning candidate at Harvard University and head of the urban observatory Impostergable*	**Expert 04:** *Urban Analyst for sustainable mobility in the Municipality of Lima*	**Expert 05** *Urban consultant for heritage areas in the Municipality of Lima*	**Expert 06** *PhD candidate at Pontificia Universidad Católica de Chile, specializing in informal commerce in the city.*	
Greenery	2	2	2	2	1	1	1.67
Pavement width	4	4	3	5	4	4	**4**
Street lighting	3	2	3	2	2	3	2.5
Spatial openness *(The degree of enclosure or the perception of space as closed or constrained)*	3	2	2	1	1	2	1.83
Pedestrian priority of streets	5	3	5	5	4	4	**4.33**
Functional mix *(Diversity of uses in a block or street segment)*	3	2	2	3	2	2	2.33
Shade availability	4	3	4	2	2	3	**3**

Retail entrance density *(Groundfloor storefront entrances density in a street)*	5	3	3	4	3	4	**3.67**
Opportunity space availability *(Underused or extra space in a street, such as underused car parking or carriage lanes)*	5	4	5	4	4	5	**4.5**
Visibility *(The degree to which an environment provides unobstructed visual access across a space. It reflects how much of a space is visible from a point)*	5	4	4	4	4	4	**4.17**

After the expert evaluation, the selection of variables was revised based on the observations made during the site visit in September. The six chosen variables were considered both relevant and feasible for evaluation. However, it became apparent that shade availability, whether from buildings or tree canopies, did not significantly impact the spatial behavior of street vendors. This is because vendors use their own sun protection devices, such as umbrellas. This observation was further corroborated by a high-resolution drone image of the study site taken on December 10th, during the spring season, which provided clear evidence of the vendors' reliance on these personal sun-shading devices. Furthermore, very few streets in the area have trees, which would make the analysis, in terms of shadow provided by trees, unreliable. Therefore, shadow availability was not considered for the analysis.

4.4. Built environment variables data collection

The identification of key built environment factors to evaluate their influence on street vending spatial behavior resulted in 5 variables: street functionality, retail entrances density, pavement width, opportunity space availability, and visibility. The following sections will describe each variable including its definition, data gathering and analysis.

4.4.1. Street functionality type

Street functionality refers to the primary use of a street, particularly in terms of accessibility and the type of users it accommodates. In the study area streets serve three different functions: vehicular-dominated roads, pedestrian-only roads, and shared streets where pedestrian, cars and other vehicles coexist. Figure 12 illustrates the classification of streets within the study area.

Figure 12: Classification of streets by functionality within the study area

Recognizing that different street types may influence various types of street vendors spatial behavior, affecting their interactions with potential customers, accessibility, and overall comfort, the experts identified street functionality as a key variable for analysis.

The analysis of this variable involved comparing the average vendors density for (for each vendor type) for segments classified as vehicular streets, pedestrian-only streets, and shared streets. To facilitate this comparison, the segments of the street network in the study area model were classified accordingly. This classification was primarily based on information from the diagnose section of the *Plan Maestro del Centro Histórico al 2029 con Visión al 2035* (Master Plan for the Historic Center of Lima to 2029 with Vision to 2035) and was verified through on-site observations (figure 13). The map highlights Jr. Andahuaylas as the main pedestrian axis, from which several pedestrian and shared streets branch out.

Figure 13: Types of streets based on functionality: vehicular, pedestrian and shared.

4.4.2. Retail entrances density

Retail entrances density is a variable that measures the concentration of shop entrances within a given street segment. As described in the literature review, there is significant relationship between street vendors and storefronts. Beyond attracting potential customers, shorter distances between entry points to shops, creates frequent pauses in pedestrian movement, increasing the opportunities for interactions between street vendors and passersby. In contrast, long frontage plots, with fewer access points, reduce these pauses, limiting the chances for vendors to interact with pedestrians (Jwalant, Urvashi, & Mayuresh, 2024).
Considering the commercial nature of the site, this study aims to determine whether, and to what extent, the concentration of shop entrances along a street influences street vendors' location choice.

The density of shop entrances per street segment was calculated as:

$$Retail\ entrances\ density = \frac{Number\ of\ retail\ entrances\ in\ a\ street\ segment}{Street\ segment\ length}$$

Data collection for this variable involved manually counting retail entrances on both sides of each street within the study area using the recorded site videos and Google Maps. These entrances were then mapped as points in the Rhino model. To calculate retail entrance density per street segment, the points were projected onto the nearest street segment, and a 1-meter buffer was applied around each segment. The number of retail entrances within each buffered area was then counted to determine the density for each street segment. The counting was then normalized per 100 m to obtain the final density. Figure 14 shows a heatmap that illustrates the density distribution of retail entrances per street segment. Red represents the highest density values, while blue the lowest. (insert description of the map)

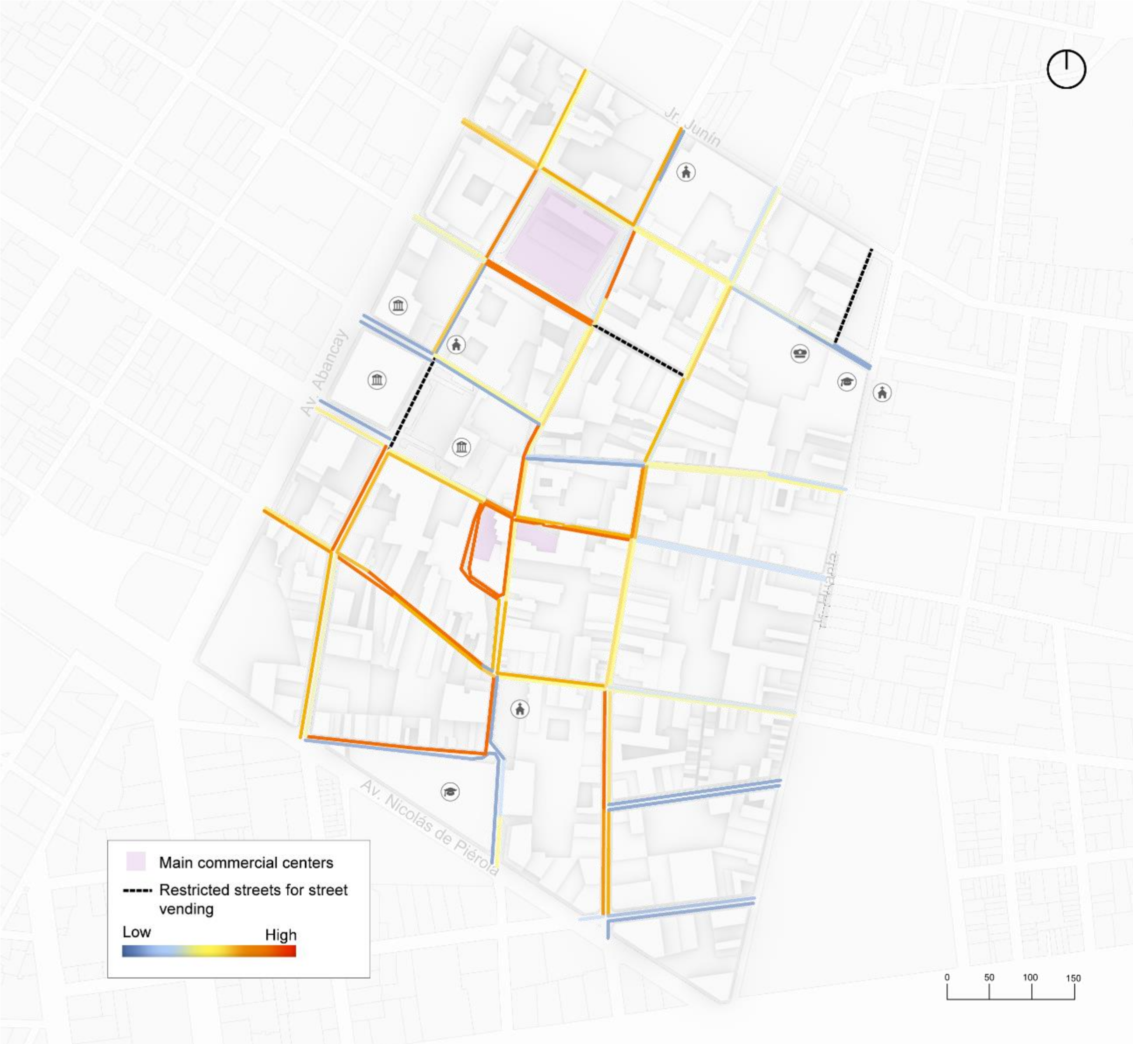


Figure 14: Retail entrances density per street segment heatmap

4.4.3. Pavement width

Pavement width directly influences the availability of operating space for street vendors. Wider and well-maintained pavements not only provide more room for vending activities, but also contributes to smoother a safer walking experience for pedestrians (Zhang & Shao, 2024). This facilitates the coexistence between vendors and pedestrian traffic.

The analysis of this variable seeks to understand how the location choices of different types of street vendors in the study area might be influenced by pavement width, given that their space requirements vary depending on the type of stall they use. Additionally, this study aims to challenge the common perception that street vendors occupy pavements without considering accessibility for pedestrians.

Data collection for this variable began with modeling the pavements using a high-resolution image of the study area. To calculate the average pavement width for each street segment, the following steps were taken: First, each side of the blocks was divided into points every 5 meters. These points were then projected onto the perimeter of the pavement. Next, lines were created between each set of points to represent pavement widths. Given that the unit of analysis is the street segment, the lengths of these lines were assigned to the closest street segments, and the average pavement width for each segment was calculated based on these values (figure 15).

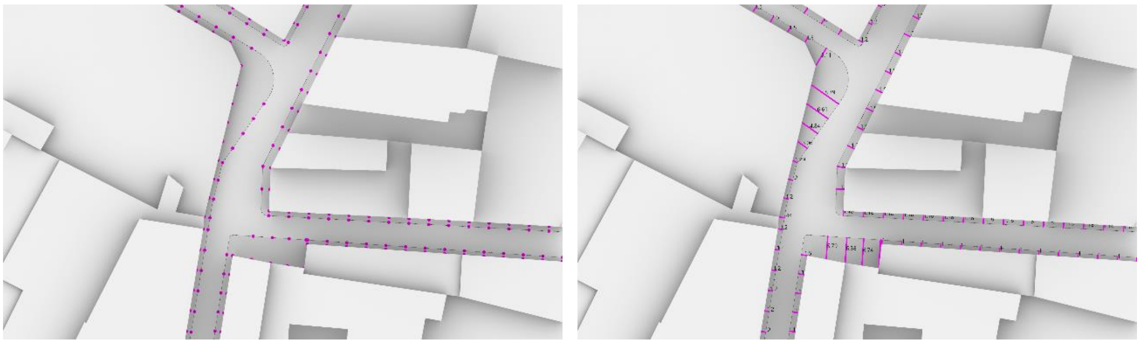


Figure 15: Average pavement width calculation process

The following heatmap in figure 16 shows the average pavement width per street segment within the study area. Streets with the widest pavements are highlighted in red, while those with the narrowest pavements are shown in blue.

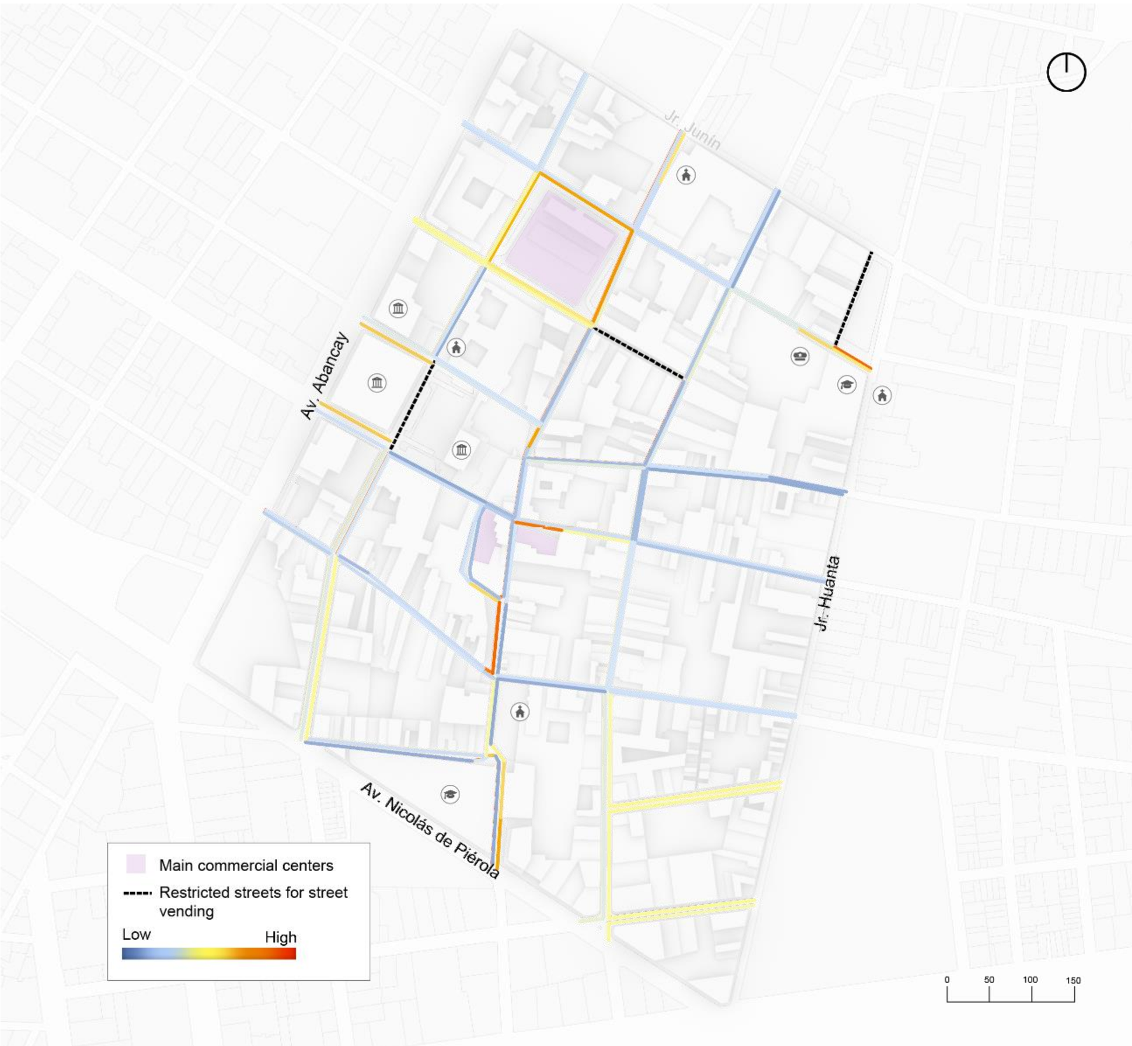


Figure 16: Pavement width average per street segment heatmap

This analysis not only compare the built environment variable to street vending density per street segment, but also to the density of street vending occupation on pavements per street segment. To achieve this, it was first necessary to calculate a pavement occupation index for each street segment which was calculated as:

$$Pavement\ occupation\ density = \frac{Number\ of\ street\ vendors\ in\ a\ pavement}{Pavement\ area}$$

To calculate the pavement occupation density, the pavement surfaces within each block were first divided according to their corresponding street segments. Then, the number of points representing street vendors that fell within each pavement surface was counted. The occupation density for each pavement surface was obtained by dividing the number of vendor points by the total surface area of that pavement. Finally, these pavement surfaces were assigned to the nearest street segment, allowing for the calculation of a pavement occupation index per street segment. Figure 17 shows a heatmap of the results. Red indicates the highest value for pavement occupation index, while blue represents the lowest.

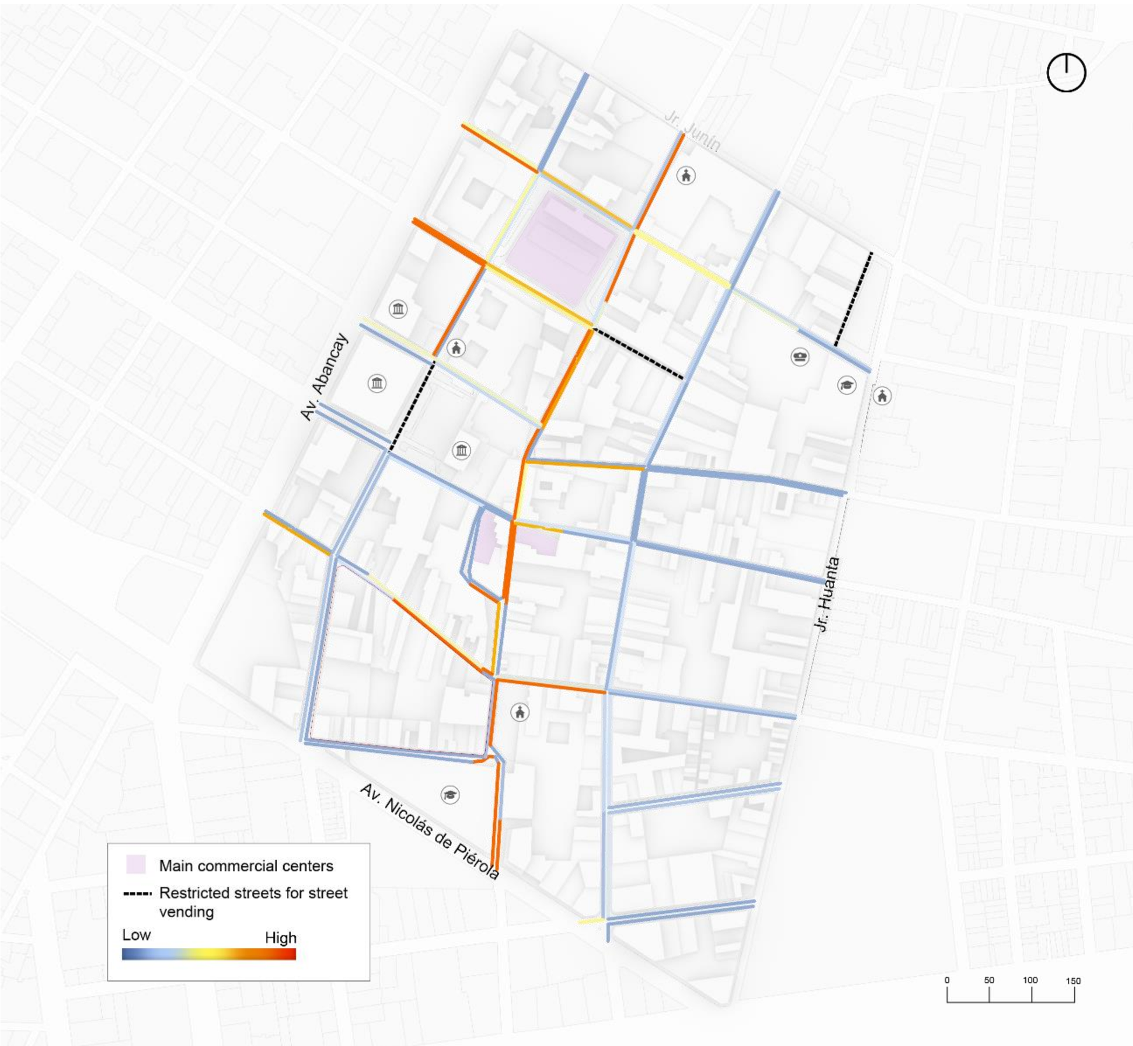


Figure 17: Pavement occupation density per street segment heatmap.

Furthermore, the street segments were clustered into 4 categories according to their pavement width (0 -1.19, 1.20 m – 2.39, 2.40 – 3.59 m, and 3.60 – 11.00 m), as shown in figure 18, with the goal of counting how many street vendors are located in each pavement width cluster, and asses the spatial conditions of street vending. These categories of pavement width were chosen based on the guidelines for public space from the *Plan Maestro del Centro Histórico al 2029 con Visión al 2035* (Master Plan for the Historic Center of Lima to 2029 with Vision to 2035).

According to this plan, the minimal normative pavement should be 1.20 m and for the integration of street vending, it should be 2.40 m and 3.60 m depending on the type of stall (see figure 5). This would mean that street vendors in the first category are located in sidewalks with a width that doesn´t satisfied the minimal requirements for pedestrians. Street vendors in the second category are obstructing pedestrians because their space requirements don´t fully fit. Finally street vendors in the third and fourth category would be the only ones authorized to be in the pavement according to spatial regulations.

Figure 18: Street segments categorized per pavement width cluster.

4.4.4. Opportunity space availability

As street vendors working area is public space, they use city spaces facilities as physical capital for their business (Sandhika, Sholihah, & Yuli, 2024). The variable opportunity space aims to analyze the use of these city spaces facilities. For this study, based on the site observations and expert consultation, it encompasses areas, other than sidewalks, that while not officially designated for street vending, provide potential operating space for vendors. In the site visits it was observed that theses spaces usually emerge from underutilized or temporarily available sections of a street, such as parking spaces and carriage lanes.

Studying the relationship between street vendors spatial behavior and opportunity space is essential to understand how informal economic activities integrate into urban environments and how public space is organically negotiated between different users. While previous research in Peru suggests that pavements are the primary workspace for street vendors (Ruiz Miranda, 2023), preliminary site observations indicate that when opportunity spaces are available, vendors tend to prefer them over the pavement. This suggests that opportunity space may play a significant role in shaping the spatial distribution of vendors, potentially reducing congestion on sidewalks. Therefore, this research aims to analyze how the presence of underutilized parking spaces or carriage lanes influences the density and distribution of different types of street vendors and their use of the pavement. Then this analysis, as the previous one, looks at the relationship of the built environment variable with not only street vending density, but also with pavement occupation density.
Understanding this relationship can provide insights into how street vendors adapt to the built environment and how urban design can better accommodate informal economic activities.

To quantify the availability of opportunity space relative to each street segment, an Opportunity Space Index was calculated. This index was determined by dividing the total area of identified opportunity spaces by the length of the corresponding street segment.

$$Opportunity\ Space\ \ Index\ = \frac{Total\ opportunity\ space\ area}{Street\ segment\ length}$$

For this variable, the data collection required to model the surfaces of the opportunity space, such as parking areas and carriage lanes. This was done by using a high-resolution image and the recorded videos of the site. Once the surfaces were modelled, they were assigned to the closest street segment to compute the Opportunity space index. The resulting heatmap (figure 19) visually exhibit the resulting index values per street segment, where red indicates the highest availability of opportunity space and blue the lowest.

Figure 19: To the left, map of the opportunity space in the study site. To the right, opportunity space index per street segment heatmap.

4.4.5. Visibility

Visibility analysis studies the relationship between urban space morphology and the visual experiential qualities perceived by users (Koltsova, Tunçer, & Schmitt, 2013). In the case of street vendors, visibility is crucial since the way a space is structured can impact how easily vendors can be seen by potential customers, which is directly related to sales opportunities and incomes (Zhang & Shao, 2024).
However, it is important to consider in this analysis that visibility can have a contradictory role in relation to the types of street vendors, since in certain cases a high visibility can stimulate eviction, especially where informality is considered harmful (Kamalipour & Peimani, 2019). In such cases, vendors may actively seek less visible spots to avoid Municipality security. Thus, visibility could both enhance business potential and increase vulnerability.

This research used the isovist to analyze visibility in the study area. The isovist can be defined as the visual field that is wholly visible from a certain single point, called the vantage point. In a 2D study, the isovist is represented as a 2D polygon (Garnero & Fabrizio, 2015). Isovist analysis can derive several visibility properties that help understand the visual perception of a space from a specific point or area. For this research we looked at isovist area.

Isovist area refers to all the visible area from a point represented as a polygon (Luyao, Papastefanou, & Ng, 2020). Higher values are associated with openness and spaciousness, while lower values with more enclosed spaces (Malte Wiener, 2008). Therefore, vendors located in large isovist areas, might be in more open spaces, which give them more exposure and accessibility to pedestrians.
This measure can help to understand the dynamics of street vendors´ spatial behavior in terms of visibility. The isovist area could suggest whether vendors consider being in

more open spaces as a benefit for their exposure to potential consumers, or if it is not a relevant spatial characteristic and other factors have a stronger influence.

To be able to compare isovist area to the street vending density, the street segment was used as the analysis unit. However, to get more precision, street segments were divided every 20 meters. To calculate visible area, an isovist analysis was done using the Rhino model of the site and the Decoding Spaces toolbox in Grasshopper. First, vantage points were placed every 5 meters along the street sub-segments, allowing for a more detailed analysis. The vantage points were then connected to the isovist component, along with the obstacle lines, which were generated by exploding the building footprints perimeters. The isovist component calculates visible area for each vantage point along the street sub-segments.
To obtain the visible area per street sub-segment, the value for each vantage point were assigned to its corresponding street sub-segment. Then, the average value for each measure was calculated across all vantage points within each sub-segment. The heatmaps below (figure 20) show the resulting visual representation for the two analyzed visibility properties within the study area. Red indicates the higher values, while blue the lowest.

Figure 20: Isovist area average per street segment heatmap.

4.5. On-site interviews to street vendors

As part of the qualitative study of this research, semi-structured interviews were conducted on-site. The aim of these interviews was to complement the results from the quantitative analysis and observations.

The interview was structured into three sections. The first section included general questions aimed at identifying the type of products sold by the vendor, their mobility patterns, and the main reasons behind their location choices. The second and main section, focuses on questions related to the influence of the selected built environment variables, including the availability of shadow, on the spatial behavior patterns of street vendors. The third and final section seeks to explore other factors, both within and beyond the built environment, that may influence street vendors spatial patterns and conditions.

The interviews were conducted with a random sample of 20 street vendors within the study area and was conducted on a Saturday between 10:00 and 13:00. The interviews were recorded using a smartphone and then transcribed to facilitate detailed analysis. A summary of the results from the interviews are exhibit in the following table (table 5).

Table 5: Interviews´ summary of findings.

Section	Question	Answers		
		Main findings	**Transcript sample**	**Other findings**
1	What **type of products** do you sell?	Wooden objects, fruits, clothing, bags, plastic objects, juice, traditional candy, textiles, sanitary products, household's tools, shoes, caps, traditional street food, water bottles, etc.		
	What led you to choose this particular **location** and what are its advantages?	The main reason for the location choice of the interviewees is high pedestrian movement.	*"Elegí este lugar porque pasa bastante gente y puedo vender más."*	From the 20 interviewees, 3 street vendors did not choose their location, but were assign a space by a street vending association.
	Do you **change locations** throughout the day or week? If so, what motivates you to do so?	From the 20 interviewees, 15 are stationary and 5 change their locations during the day.		
2	Does the **pavement width** influence you location choice or affect your work in any way?	The majority of street vendors do not consider pavement width as an important factor for their location because the majority position themselves in the opportunity space.	*"El ancho de la vereda no nos afecta, porque nosotros nos adecuamos al espacio que hay."*	The only 3 interviewees who occupied the pavement, did considered pavement width important for theirs and the passersby comfort.
	Does the **availability of shadow** in the urban environment influence your locations choice or affect your work in any way?	From the 20 interviewees, 17 used an umbrella and 19 of them expressed the importance of shadow for their comfort, because heat is a very important consideration when it comes to their working conditions.	*"Si, el calor es una gran desventaja. Por eso tengo mi sombrilla, pero si me gustaría estar cerca de árboles si habría."*	5 street vendors expressed their preference for shadows coming from trees, instead of the use of their own devices.
	Is the **proximity to store entrances** important for your location or does it affect your work in any way?	Out of the 20 interviews 12 expressed that the proximity to store entrances is crucial mainly the movements of customers inside and out of the stores provide them with an opportunity to sell to them.	*"Si afecta, porque las personas entran y salen de las tiendas y esa es nuestra oportunidad para venderles, si es que algo les faltó comprar."*	2 Interviewees mentioned their products complement the stores and they benefit from the same clients.

	Does the **availability of extra space** (parking or carriage lanes) influence your location choice or affect your work in any way?	Out of 20 interviewees, 17 used the opportunity space in streets because pavements in the study area are generally not wide enough. However, 9 street vendors expressed that parking and carriage lanes are not comfortable, because they lose operating space when cars, motorcycles, or carriers occupy the space.	*"Yo estoy aquí porque acá había espacio, pero cuando vienen los carros o motos a estacionarse nos incomodan"*	Parked cars and motorcycles, and agglomeration of carriers are a disadvantage to street vendors, both in the opportunity space and in the pavements because they obstruct their visibility and the possibility to sell.
	Does the **visibility** of your location affect your work?	Out of 20 interviewees only 2 are located in a corner. However, 10 expressed their preference for a corner because they would be more visible to potential customers, 6 expressed their preference for the street because there is pedestrian flow and they feel it is calmer, and 4 had no preference.	*"Estoy bien aquí en la calle, acá hay espacio, pero preferiría las esquinas porque se vende más."*	2 interviewees expressed their preference for the street because they are less exposed to municipality security.
	Do you think **the type of street** where you work (only-pedestrian or with motorized traffic) influences your sales and/ or comfort?	Out of 20 interviewees, 12 expressed that they prefer pedestrian-only streets because they feel uncomfortable with the noise and pollution that the cars produce. Also, vehicles make them feel unsafe and their presence makes it harder to sell.	*"Los carros incomodas y el ruido me molesta muchísimo, además que cuando pasan no dejan vender."*	5 interviewees expressed no preference when it comes to the street type, mainly because they are located in streets with wide pavements, which makes pedestrians and street vendors feel comfortable. Additionally, 3 street vendors preferred vehicular traffic, because people in cars buy their products.
3	Besides the physical space, what **other factors** influences your location choices?	The presence of police and municipality security play crucial roles in the spatial behavior of street vendors. While police make street vendors feel safe, municipality security take their products away and evict them from their locations.	*"La policía si me favorece porque nos dan seguridad, pero los municipales nos quitan nuestras cosas y se las roban"*	
	If you could change something about the urban environment here to improve your sales or working conditions, what would it be?	The carriers are a recurrent complaint from street vendors, because they do not respect their lanes and move through the pavements, contributing greatly to chaos and pedestrian traffic. Street vendors often express a desire for increased order and organization in their operating environments. They advocate for municipal interventions that reorganize vending locations to enhance their selling opportunities	*"Los carretilleros no respetan, pasan por donde quieren, nos incomodan y hacen difícil la venta"* *"En general me gustaría más orden en los vendedores, que la municipalidad nos reorganice."*	

5. Results

The following section will assess the results from the analysis of the relationship between the spatial behavior patterns of street vending and the selected built environment variables. The results include the computational and qualitative analysis.

5.1. Street functionality type

5.1.1. Results from the quantitative analysis

To assess the relationship between street vending density and street functionality type, the average density of street vendors per street functionality was calculated. The results indicate a high density of vendors in pedestrian streets, averaging 21.1 vendors per segment. While, shared streets obtained 7.4 and vehicular streets have the lowest density, averaging 5.1 vendors per segment (see table 6).

Table 6: average street vending density per street segment functionality type

Average street vending density per street functionality type			
Street vending type	**Type of street**		
	Vehicular	**Pedestrian-only**	**Shared**
All street vendors	5.1	21.1	7.4
Mobile kiosks	2.1	3.8	3.1
Trolley and tricycles	0.9	1.0	0.6
Floor mats	0.1	1.4	0.3
Hanger and tables	2.0	14.2	3.7

This significant difference suggests that street vending thrives in pedestrian-friendly environments with minimal vehicular interference. This pattern is also evident in figure 21, where pedestrian streets align with the highest vendor densities.

Figure 21: Street functionality type map and street vending density per street segment heatmap

Across vendors type, the results indicate that hangers and tables have the highest density in pedestrian-only streets (14.2 vendors per segment), suggesting that vendors using stationary setups prefer areas with high foot traffic and minimal vehicular interference. Similarly, but with overall lower densities, the results for floor mat vendors indicate a preference for pedestrian streets (1.4 in pedestrian-only, 0.3 in shared, and just 0.1 in vehicular streets)
Mobile kiosks and trolleys and tricycle are more evenly distributed, with densities of 3.8 in pedestrian-only, 3.1 in shared, and 2.1 in vehicular streets for mobile kiosks and 1.0 in pedestrian-only, 0.6 in shared, and 0.9 in vehicular streets for trolleys and tricycles. This suggests that vendors with mobile setups tend to adapt better to different type of streets.

5.1.2. Results from the qualitative analysis

Based on this analysis and to further understand the results, the heatmaps from the analysis were used to compare the street vending density in different street types and across the categories of vendors. This was done with the aim to observe differences and similarities and select relevant streets to look more closely at. An observational study was conducted to identify smaller-scale spatial patterns in each type of street that the statistical analysis does not capture. For this examination of the video recordings from the site visits and the interviews were used to gain further insights.

Pedestrian-only streets

The statistical results, are supported by the interview, with 60% of the respondents saying that they prefer to work in only-pedestrian streets.

Figure 22: Street vending density distribution across all vendor types only in pedestrian streets

Zone 1 and 2 (see figure 22) show a high density of stationary vendors with hangers and tables, while other vendor types are less represented. Observations indicate that hangers and tables type vendors benefit the most from pedestrian streets with high foot traffic, such as Jr. Andahuaylas and jr. Puno. These streets provide the spatial opportunities for vendors to display their products. Despite varying road dimensions, vendors occupy the streets and can sometimes occupy the pavement (see figure 23), as pedestrians can walk in the middle of the street. In contrast, while floor mat vendors are

considered stationary, their presence is limited, likely due to the high movement environment of this street, which is uncomfortable for groundfloor activities.
Additionally, other observations showed that when pedestrian streets are wide enough, vendors will position themselves along the site of the road to allow pedestrian traffic in the pavement and in the middle of the road, benefiting from potential customer from both sides.

Figure 23: Pedestrian streets with vendors occupying the pavement.

Zones 3 (Mercado Central) and **4** (Mesa Redonda) showed higher densities of mobile and semi-stationary vendors. A common pattern between these areas is the smoother pedestrian traffic, likely due to the absence of hangers and tables. The lack of stationary vendors is primarily attributed to the presence of municipal authorities, which seems to create more space for mobile vendors to operate in pedestrian areas.

Shared streets

Shared streets have a moderate density of street vendors per segment across all street types. The observations indicate that vendors using floor mats for their setups rarely position themselves in these streets. As these vendors are among the most vulnerable in terms of working conditions and visibility, this may suggest that the chaotic mix of users (pedestrians, motorcycles, cars, and carriages) presents a threat to their safety.

On the other hand, mobile kiosks appear to be the most adaptable setup for this. As seen in figure 24, the compactness and enclosed design of their setup, allows them to operate in the sidewalks and roadsides, without high impacts on traffic. Furthermore, interviews indicated that food vendors using mobile kiosks also benefit from selling to drivers, as some cars stop to purchase food

Figure 24: Street vendors in shared streets.

Vehicular streets

Figure 25: Street vending density distribution across all vendor types only in vehicular streets.

The density of street vendors is the lowest in vehicular streets across all vendors. This is supported by the interviews, as they expressed that vehicular traffic negatively impacts their working conditions and efficiency of their business due to noise, air pollution and the disruption of the interactions with pedestrians.

Mobile kiosks and trolleys/tricycles appear more compatible with vehicular streets due to their compact, mobile setups. Additionally, observations and interviews indicate that some of the products they sell, such as food, snacks, and drinks, are in demand among car drivers. **Zones 1 and 2** exhibit vehicular streets with mobile vendors operating (see figure 26).

Figure 26: Street vendors in vehicular streets.

The results suggest that stationary vendors are generally incompatible with vehicular streets. However, **Zone 3** is one of the few exceptions, where stationary and mobile vendors occupy road space and impact traffic. Site observations clarify this anomaly, as this area is part of Chinatown, which attracts a high number of customers, creating a strong demand for street vending despite traffic constraints (see figure 27).

Figure 27: Street vendors in vehicular streets from Chinatown.

5.1.3. Findings overview

H1: Overall, street vendors tend to be more densely located in pedestrian-only streets, while they avoid streets prioritizing motorized-vehicles.

The findings support **hypothesis 1**, as the results from the initial statistical analysis suggest that across all street vendors, there is a preference for pedestrian streets, while motorized vehicle roads are generally avoided. This was confirmed by the observations and interviews, that exhibited the preference for pedestrian streets, due to vehicles not only affecting negatively their business by limiting the interactions with pedestrians, but also affecting their working conditions with noise and air pollution. The results also showed that stationary vendors are almost only compatible with pedestrian streets, due to space and operation requirements. On the other hand, mobile vendors seem more adaptable to different environments.

The observations and interviews, revealed smaller scale patterns:

- Stationary vendors are strongly attracted by highly visited commercial areas and regardless of the functionality type of street, they adapt their operations to the spatial constraints.
- When pedestrian streets are wide enough, stationary vendors will locate themselves alongside the roads, leaving the sidewalk and center of the road free for pedestrian, benefiting from customers from both sides.
- Given the vulnerability of floor mat vendors, they prefer pedestrian streets with smooth pedestrian flows.
- Although, generally, mobile vendors prefer pedestrian streets, they can benefit from selling their products to car drivers.

5.2. Retail entrances density

5.2.1. Results from the statistical analysis

To assess the relationship between street vending density and retail entrance density, Spearman´s correlation coefficient was calculated for the different types of vendors (see table 7). The results indicate an overall weak positive correlation (r_s = 0.13) and across all vendor types, which suggest that, while streets with a high density of storefronts may attract some vendors, there are other influencing factors at play.

Table 7: Correlation between street vending density and retail entrances density per segment

Correlation between street vending density and retail entrances density	
Street vending type	**Spearman´s correlation coefficient (rs)**
All street vendors	0.13
Mobile kiosks	0.14
Trolleys and tricycles	0.24
Floor mats	0.09
Hangers and tables	0.08

The results also exhibit that trolleys and tricycles have the strongest correlation (r_s = 0.24), followed by mobile kiosks (r_s = 0.14), which could indicate that the most mobile type of vendors, are the one benefiting the most from the potential interaction with customers product of the pedestrian movement patterns influenced by high density of retail entrances. In contrast, floor mats and hangers and tables (r_s = 0.09, r_s = 0.08) present the weakest correlations. This suggests that vendors with more stationary setups may prioritize other economic, social, spatial or regulatory factors.

5.2.2. Results from the qualitative analysis

Based on this analysis and to further understand the results, an observational study was conducted to identify spatial patterns and contextual factors that statistical analysis does not capture. For this, the top 10% of streets with the highest retail entrance density were identified using the heatmap from the computational analysis. These high-density retail entrances zones were then compared to the street vendor density heatmaps across all vending types to assess the extent of their alignment (see figure 28).
Following this comparison and observing differences in matches and mismatches across vendor types, a detailed examination of these zones was carried out using the video recordings and interviews, to gain further insights into the interactions between retail entrances and street vending activities.

Figure 28: Comparison between retail entrances density heatmap and street vending density heatmap.

Zone 1 encompasses the streets located to the south and east of Mercado Central (see figure 29). The southern street, despite its high density of retail entrances, has a low presence of hangers, tables, or mat-type vendors. This may be due to the presence of municipal authorities restricting stationary vending and the lack of available space. In contrast, trolleys are more common, likely because their mobility and no permanent occupation makes them more tolerated. On the eastern street (see figure 29), where no authorities were observed and more space is available, the presence of hangers and tables increases

Figure 29: To the left, south street to Mercado Central. To the right east street to Mercado Central.

Furthermore, as confirmed with the interview, the observations suggested that small trolleys and mobile kiosks benefit the most from proximity to retail entrances. As illustrated in figure 30, these types of vendors strategically position themselves beside entries, taking advantage of costumer’s movement in and out of shops to increase interactions and potential sales.

Figure 30: Pictures of trolleys and mobile kiosks beside retail entrances.

Zone 2 encompasses the area surrounding Mesa Redonda (see figure 28). Similarly to the previous zone, despite a high density of retail entrances, street vendor density is low, which could be attributed to municipal restrictions and spatial limitations. Additionally, the predominance of eyewear and electronics shops, combined with the street´s location off the main route to other destinations, limits the number of potential customers, reducing sell opportunities for street vendors. Despite these limitations, trolleys and mobile kiosks selling food were present. Observations suggest that their primary customers were workers in the area, including retail employees and carriers (see figure 31).

Figure 31: Pictures of zone 2, around Mesa Redonda

Zone 3, Unlike the previous areas where municipal authorities were not observed and more space is available, exhibits a higher concentration of hangers, tables and floor mat-type of vendor. A similarity in the type of products sold by shops and street vendors was identified, suggesting that stationary street vendors can benefit from the customers from the formal shops. Furthermore, it was observed that floormat vendors tend to operate along blind walls rather than near shops. This may be because to business activities, promotional displays, and pedestrian traffic on the shopfront side, which could create discomfort for vendors operating at ground level (see figure 32).

Figure 32: Pictures of zone 3

Zone 4, includes jr. Cusco and jr. Andahuaylas. When observing the heatmaps (see figure 28), while both streets have a high density of retail entrances, jr. Andahuaylas have a higher density of street vendors than jr. Cusco. This is mainly explained by pedestrian movement. Jr. Andahuaylas, being the main axis in the study site, has the highest pedestrian movement, attracting vendors, indistinctively of the density of shops, type of retail, and other factors like the availability of space. Jr. Cusco has only a moderate pedestrian flow (see figure 33).

Figure 33: Comparison between retail entrances density, street vending density and pedestrian flows.

Further supporting this finding, the analysis of the southern street segment, highlighted with a purple circle in the maps in figure 33, reveals an interesting pattern. This segment, located on Jr. Andahuaylas, has a low concentration of retail storefronts. Nevertheless, street vending density remains high due to the significant pedestrian movement along this main axis.

5.2.3. Findings overview

H2: Overall, street vendors tend to be more densely located on streets or side of the street with a higher concentration of retail entrances

The findings partially support **hypothesis 2**, as based on the initial statistical analysis, there seems to be a low correlation between street vending density and the retail entrances density, across all types of vendors. However, the site observations showed that these results might be influenced by the presence of municipal authorities, the availability of space and foot traffic.
Generally street vendors tend to locate themselves in streets with high pedestrian traffic, which is incremented by the presence of shops. This was confirmed by the interviews, where 85% of the participants stated that they chose their locations because of high pedestrian movement, while 60% of them said that the proximity to retail entrances is relevant.

The observations and interviews, revealed smaller scale patterns:

- Small trolleys and mobile kiosks have a strong relationship with retail entrances, locating themselves directly beside them to benefit from the flow of people entering and exiting. In contrast stationary vendors do not apply this strategy, due to their need for more space.
- In streets where pedestrian flow is not particularly high, stationary vendors seem to locate themselves in streets with shops selling similar or complementary items.
- Street vendors operating with floor mats, when possible, seem to avoid locations right beside retail entrances, because the high movement in those spaces can be uncomfortable operating at the ground level.
- Mobile kiosks selling food, tend to offer their products to formal workers in shops, particularly at lunch time.

5.3. Pavement width and opportunity space availability

This analysis explores the relationship between pavement width and opportunity space in relation to street vending density and pavement occupation density. The results provide insights into how these spatial characteristics influence the distribution and occupation patterns of street vendors.

5.3.1. Results from the statistical analysis

Pavement width and street vending density show almost no correlation, with a coefficient of $r_s = 0.03$ (see table 8). This suggests that pavement width has little to no influence on the overall density of vendors. When compared with pavement occupation density, pavement width shows a weak positive correlation with a coefficient of $r_s = 0.17$ (see table 9).

Table 8: Correlation between street vending density and average pavement width per street segment.

Correlation between street vending density and average pavement width	
Street vending type	**Spearman´s correlation coefficient (rs)**
All street vendors	0.03
Mobile kiosks	0.20
Trolleys and tricycles	-0.05
Floor mats	-0.10
Hangers and tables	0.02

Table 9: Correlation between pavement occupation density and average pavement width per street segment.

Correlation between pavement occupation density and pavement width	
Street vending type	**Spearman´s correlation coefficient (rs)**
All street vendors	0.17
Mobile kiosks	0.32
Trolleys and tricycles	0.09
Floor mats	0.09
Hangers and tables	0.13

The results also suggest that, among all vendors types, Mobile Kiosks are slightly more concentrated on wider pavements, with pavement showing a correlation coefficient of r_s = 0.20 with street vending density and r_s = 0.32 with pavement occupation density. Other vending types exhibit weak or negative correlations, suggesting their distribution is not dependent on pavement width.

Furthermore, the results of the number of street vendors per pavement width cluster (see table 10) show that 72% of the vendors occupying pavements do not meet the required pavement width for their own and pedestrian comfort, according to *Plan Maestro del Centro Histórico al 2029 con Visión al 2035* (Master Plan for the Historic Center of Lima to 2029 with Vision to 2035). This is caused because 70% of pavements in the study site are below the minimal width required to hold street vendors.
Moreover, 16% could be even causing a total obstruction of the sidewalk, because in this category they don´t even meet the minimal requirements for pedestrians.

Table 10: Number of street vendors per pavement width cluster

Number of street vendors per pavement width clustering		
Pavement width (m)	**Number of street vendors**	**Percentage**
0 – 1.19	217	16%
1.20 – 2.39	799	56%
2.40 – 3.59	204	14%
3.60 – 11.00	199	14%

Opportunity space and street vending density show a weak positive correlation with a coefficient of $r_s = 0.19$. When comparing opportunity space and pavement occupation density the correlation for all street vendors is negative with a coefficient of $r_s = -0.19$ (see table 11 and 12). These results suggest that on streets with more opportunity space, vendors are slightly more likely to concentrate while occupying less of the pavement.

Table 11: Correlation between street vending density and opportunity space index per street segment.

Correlation between street vending density and opportunity space index	
Street vending type	**Spearman´s correlation coefficient (rs)**
All street vendors	0.19
Mobile kiosks	0.16
Trolleys and tricycles	0.26
Floor mats	0.14
Hangers and tables	0.15

Table 12: Correlation between pavement occupation density and opportunity space index per street segment.

Correlation between pavement occupation density and opportunity space index	
Street vending type	**Spearman´s correlation coefficient (rs)**
All street vendors	-0.19
Mobile kiosks	-0.22
Trolleys and tricycles	-0.08
Floor mats	-0.10
Hangers and tables	-0.14

Trolleys and tricycles density show the highest positive correlation with opportunity space ($r_s = 0.26$), while mobile kiosk shows the highest negative correlation with pavement occupation density ($r_s = -0.22$). This suggests as opportunity space increases, the concentration of trolleys and tricycles could may increase, though their pavement occupation does not necessarily decrease. In contrast, mobile kiosks also tend to slightly concentrate more in areas with greater opportunity space, but in this case, their pavement occupation seems to decrease.

5.3.2. Results from the qualitative analysis

The statistical analysis indicates that pavement width is not a significant factor in street vending distribution and has a weak influence in the pavement occupation. The analysis for opportunity space indicated that it has a slight influence in street vending distribution and pavement occupation. These findings reveal that other factors, such as high pedestrian flows and municipal surveillance, have a stronger influence

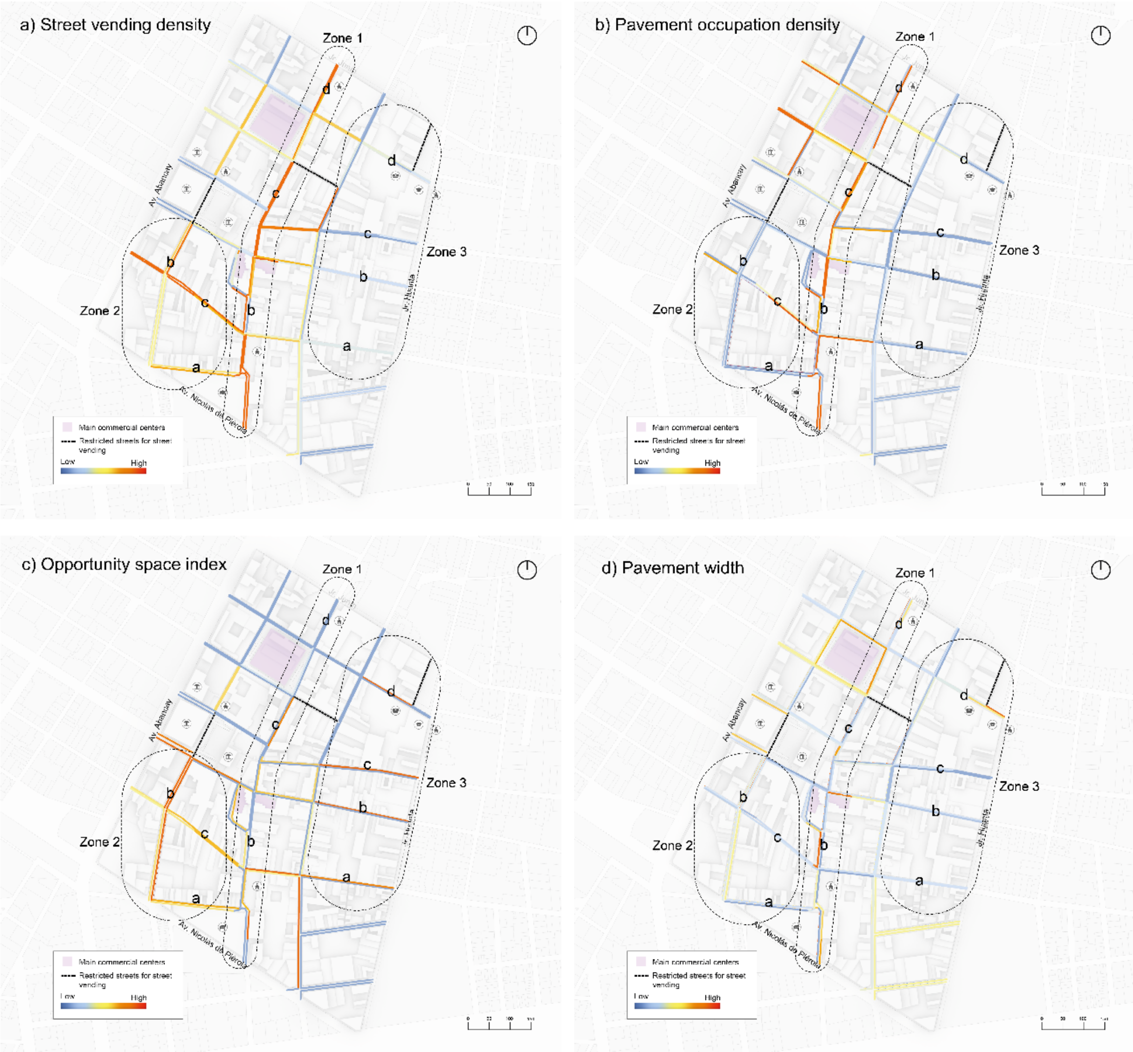


Figure 34: Heatmaps comparing street vending density, pavement occupation density, opportunity space index and pavement width per street segment.

Building up on these results, the heatmaps from the analysis (see figure 34) were used to select three zones with varying vendor density for a more detailed analysis based on the examination of on-site video recordings. This allows to understand how vendors utilize pavement and opportunity space and capture smaller-scale patterns that the statistical analysis does not capture.

Zone 1

Zone 1 encompasses observations from several sections of the main pedestrian axis, Jr. Andahuaylas, with the aim to see how within a high foot traffic and only-pedestrian area, street vendors occupy pavements and opportunity space.

Figure 35: Pavement and opportunity space occupation in zone 1,

Overall, along all the jr. Andahuaylas axis, there is a clear preference for using opportunity space rather than pavements. This aligns with the interview findings, as 17 out of 20 vendors expressed that pavement width does not influence their location choice, as they prefer to use the opportunity space.

One key reason for this preference is that street vendors feel more comfortable operating in this space, as they don´t obstruct pedestrian flow. This is particularly relevant given that most sidewalks in the area are narrower than the minimum width to accommodate street vendors comfortably. In **section a** (see figure 35), it was observed that, even when the pavement on one side of the road was wide enough, vendors still operate in the opportunity space. Furthermore, opportunity space in pedestrian streets allows vendors to attract customers from both sides, those walking along the pavement and those in the middle of the road.

Another factor influencing this preference is the presence of storefronts. On the pavement, vendor´s space is restricted by shop entrances and windows, while in the opportunity space they have more flexibility. In **section c** (see figure 35), it was observed that on pedestrian streets without opportunity space, vendors use the pavement regardless of its width, as people can still walk in the middle of the road. However, their use of space is limited to gaps between storefronts. In contrast, blind walls along one side of the road can be beneficial for vendors, as they can use all the pavement without constraints, as seen in **sections a and d** (see figure 35)**.**

Section b (see figure 35) is the only case where vendors prefer to set up on the pavement. This is because it is approximately 6 meters wide, providing enough space for them to operate on both the sides, adjacent to properties in between storefronts and the side facing the road.

It was also observed that mobile kiosks were the most common vendor type using the pavement, likely due to their compact setup, which takes up less space and minimizes obstruction to pedestrian flow. In contrast, hangers and tables were the primary users of opportunity space, as their larger setups require more room.

It is also important to clarify that the opportunity space in jr. Andahuaylas comes from the carriage lanes and not from parking, since this is a pedestrian-only zone.
Carriers are important actors in the study site, given that they transport products from the storage areas to the shops, using trolleys and handling large volumes of products (see figure). The occupation of street vendors of these lanes, forces carriers to move along with pedestrian causing congestion. However, at the same time, the interviews revealed that carriers cause a great discomfort in the operations of street vendors, because they disrupt their interactions with passerby.

Figure 36: Carriers in the study area.

Zone 2

This zone includes streets with a medium overall street vending density. These streets are still highly frequented but not as much as Jr. Andahuaylas. The patterns observed in this area are similar to the ones from zone 1.

One notable case is **Section a** (see figure 37). On one side of the street, there is a blind wall, but unlike the observations in Zone 1, vendors do not occupy the pavement in this case because there is available opportunity space. This finding further reinforces the idea that vendors have a preference for opportunity space over occupying the pavement.

Another particular observation is in **Section b**, as it is a shared street and one of the few streets with trees. With opportunity space available on both sides of the road, vendors tend to use it and, when possible, set up around a tree (see figure 37). This observation is supported by the interviews, in which vendors 17 out of 20 respondents emphasized the importance of shade, as heat is one of the main sources of discomfort within their working conditions. Although most street vendors use umbrellas, especially in the summer, they expressed a strong preference for trees in their areas to provide better protection from the weather

Figure 37: Opportunity space use and proximity to trees in zone 2

Zone 3

Zone three includes the streets to the east of the study area, which are vehicular with low pedestrian traffic. The heatmaps (see figure) reveal that most streets in this zone are outliers, as they have both low opportunity space and low pavement occupation. This can be largely explained by the overall scarcity of vendors in the area, which is attributed to its more vehicular and residential character. Although street vendor density is low, we observed the few vendors operating in this area to understand how pavement conditions and the availability of opportunity space affect them.

Figure 38: Pavement and opportunity space use in zone 3

Opportunity space in this area is limited, as parking spaces are occupied by cars, as shown in **Section c** (see figure 38). As a result, street vendors operate in the available gaps or beside parked vehicles. The pavements here are particularly narrow, leaving vendors with no option but to set up in parking areas, as observed in **Section a**, or directly on the road, as seen in **Sections b and d** (see figure 38). According to the interviews, vendors consider their location between parked cars or motorcycles as a disadvantage, as they expressed that cars and motorcycles obstruct their visibility.

The only vendor types present in these sections are street food mobile kiosks and a few tricycles, likely because their products are the only ones in demand in this part of the study area. Additionally, given the constraints of limited opportunity space and narrow pavements, their setups are the most adaptable to these conditions.

5.3.3. Findings overview

H3: While pavement width does not significantly influence street vendors´ location choice, street vendors are more likely to occupy wider pavements.

The findings partially support **hypothesis 3**, as the results of the statistical analysis confirmed that pavement width does not play a significant role in the spatial distribution of street vending. However, it was also revealed that as pavement width increases, there is only a slight increase in its use by vendors. This is primarily due to vendors' preference for opportunity space, which was confirmed by interviews, where most participants stated that their location choice is not influenced by pavement width, as they prefer to occupy the opportunity space.

H4: Street vendors tend to be more densely located in areas with opportunity space, and as the area of opportunity space in a street increase, vendors tend to occupy less of the pavement.

The findings partially support **hypothesis 4** as, the statistical analysis showed a weak correlation between opportunity space and street vending density. This finding was corroborated by the observational studies, which indicated that location choice is more influenced by factors such as pedestrian flow, municipal surveillance, and the functional type of the street. The statistical analysis also suggested that as the availability of opportunity space increases, pavement occupation slightly decreases. However, when examining occupation patterns at the street level, it was consistently observed that, regardless of pavement width, vendors tend to prioritize occupying opportunity space when it is available.

The observations and interviews revealed smaller scale patterns:

- Street vendors prefer using opportunity space to avoid obstructing pedestrian flow, as this makes both vendors and customers uncomfortable.
- In pedestrian-only streets, street vendors tend to use opportunity space because they benefit from the flow of customers on both sides.
- Street vendors use opportunity space because storefronts on the pavement constrain their operating area and flexibility. In contrast, blind walls allow vendors to freely occupy the pavement.
- Street vendors using opportunity space in streets with vehicular movement are affected by parked cars and motorcycles, as these hinder their visibility.
- Most pavements in the study area do not meet the recommended width for integrating street vending comfortably.
- Mobile kiosks are the most suitable setup for street vending on pavements, as they are compact and allow for smooth pedestrian flow.

- The main users of opportunity space are hangers and tables, due to their space requirements.
- When trees are available, vendors are more likely to position themselves near them for protection from the weather.
- Carriers use of the street, as a result of vendors occupying the carriage lanes, negatively impacts vendors´ operations and pedestrian movement.

5.4. Visibility

5.4.1. Results from the statistical analysis

The isovist area, representing visibility, exhibits almost no correlation with overall street vending density (r_s = -0.02), suggesting that visibility is not an influential factor for street vending spatial patterns (see table 13). This could be explained by two factors. First, high pedestrian traffic occurs in areas that do not necessarily have high visibility, like jr. Andahuaylas. Second, some of the most visible areas, such as the surroundings of Mercado Central and the Ministry of Justice are also places where municipal authorities are frequently present, discouraging street vendors from occupying these spaces (see figure 39).

Table 13: Correlation between street vending density and isovist area per street segment

Correlation between street vending density and isovist area (visibility)	
Street vending type	**Spearman´s correlation coefficient (rs)**
All street vendors	-0.02
Mobile kiosks	0.22
Trolleys and tricycles	0.01
Floor mats	-0.08
Hangers and tables	-0.10

When examining the results across vendor types, only mobile kiosks seem to be slightly influenced by visibility with a correlation coefficient of r_s = 0.22. The rest of vendors have correlations closer to 0, suggesting that visibility is not a determinant factor for their location choices.

Figure 39: Heatmaps comparing visibility and density of mobile kiosks in the study site.

5.4.2. Results from the qualitative analysis

Although the statistical analysis of the isovist area showed almost no connections between the spatial behavior of street vendors and visibility, the qualitative study builds up on these results, using the heatmaps from the analysis to understand in a smaller scale the implications of visibility in street vending spatial patterns.

Low-pedestrian movement areas

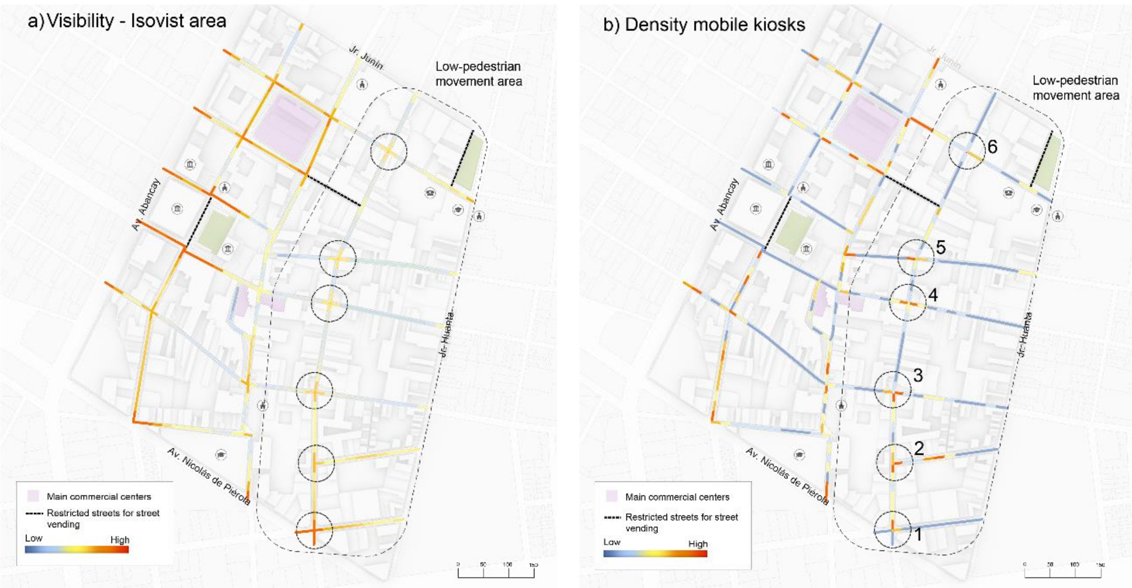


Figure 40: Heatmaps comparing visibility and density of mobile kiosks in the study site.

The visibility heatmap was compared to the street vending density heatmaps across all vendor types, with the aim to identify possible significant patterns. A notable observation came across mobile kiosk's density heatmap. Particularly when observing the areas that do not have high pedestrian foot traffic, the locations of mobile kiosks seem to rely more on high visibility, which in this case are streets' intersections (see figure 40). Using the video recordings, the use of space in street intersections was observed to get further insights.

Consistently at all intersections it was observed that the mobile kiosk specifically sold prepared food or drinks (see figure 41). The openness and exposure experienced in corners appear to be advantageous for these vendors, as they benefit from the encounter of multiple pedestrian flows. Moreover, intersections prompt pedestrians to pause, due to stops or change of direction, making it easier for vendors to interact with them. This aligns with the interviews, as several vendors expressed a preference for corners, noting that these locations allow them to sell more.
Additionally, the shape of the corner, naturally creates a gathering space, which foster the social interactions involved in food vending, that seem stronger compared to other street vending types.

Although pedestrian movement is low, corners in this area still provide a favorable environment and spatial conditions for food vendors. In the case of corners along Jr. Andahuaylas, there is also presence of food vendors; however, due to the high concentration of other types of vendors, their operations are less comfortable and more constrained.

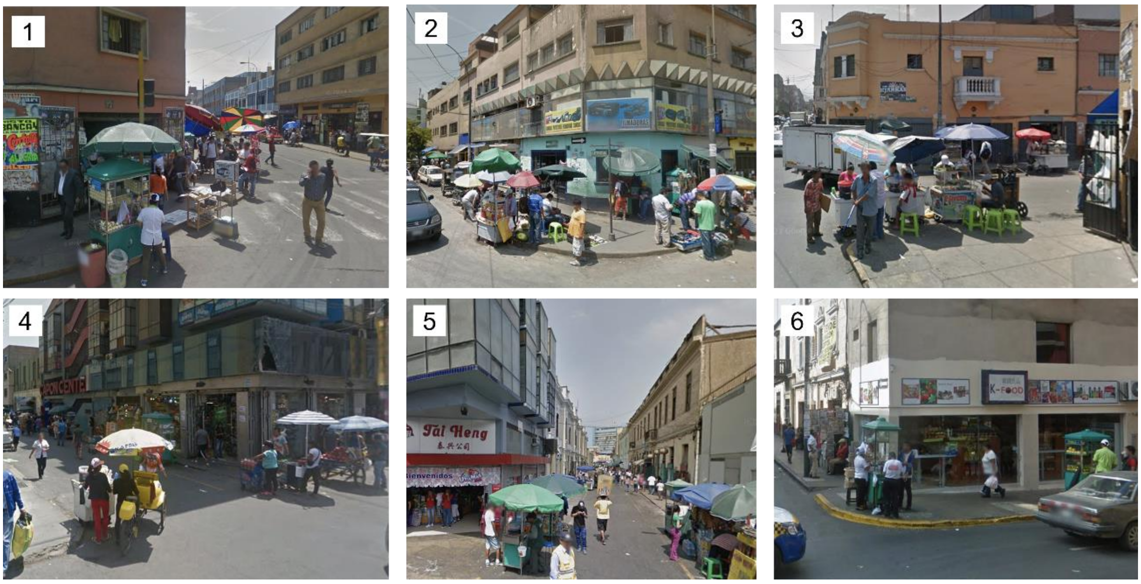


Figure 41: Street intersections in low-pedestrian movement area. Source: Google maps and own photos.

Regarding space occupation, it varies depending on the width of the pavement. If the corner sidewalk is wide enough, vendors will occupy it; however, if the sidewalk is narrow, as in the case of many intersections in this area, they will use the road. This could create a sense of insecurity and discomfort, not only for vendors but also for the customers, especially since these are vehicular streets.
It was also observed that given the limited space in in the exact corner, food vendors tend to concentrate at the start of the mid-street section, where they can still benefit from visibility.

High pedestrian movement areas

Since the statistical analysis indicated that visibility derived from the spatial configuration of the built environment does not influence the spatial patterns of street vendors in high-foot-traffic areas, the streets of Jr. Andahuaylas and surroundings (see figure 39) were examined more closely to explore whether visibility, understood in a broader sense, plays a role in street vending.

In Jr. Andahuaylas, the vast majority of vendors are stationary, occupying both corners, and mid-street sections. Observations indicate that, in high-foot traffic areas, vendors benefit from making all their products visible. Vendors selling clothing, household items, electronics, and other goods prioritize displaying their full range of products, which leads them to occupy larger areas to attract potential customers.
Another significant observation, coming from the interviews, was that parked cars and motorcycles obstruct the visibility of vendors. This can be seen mainly in shared streets as the one in figure 42.

Figure 42: Stationary vendors large occupation areas to display their range of products.

5.4.3. Findings overview

H5: Street vendors tend to be more densely located in highly visible areas.

The findings partially support **hypothesis 5,** as the results of the statistical analysis revealed that, overall, visibility does not play a role in the spatial distribution of street vendors, as pedestrian flow is a stronger determinant of their sales. Additionally, places with the highest visibility, such as parks, are under municipal surveillance, discouraging vendors from being there. However, the observations from the qualitative analysis showed a strong correlation between visibility and mobile kiosks selling food, specially in low-pedestrian movement areas. This type of vendors concentrates in street intersections and their surroundings to benefit from the exposure that a more open space, like corners give. Additionally, they benefit from high opportunities of interaction with passersby, as street intersections prompt pedestrians to pause. Furthermore, the natural shape of the corner favors the gathering of people, which aligns with the strong social interactions involved in food vending.

In contrast, in high-pedestrian movement areas, visibility coming from the spatial configuration does not influence the spatial distribution of vendors, as they are densely located in corners, as in mid-street sections. Nevertheless, the observations showed that high visibility in these areas is more related to the capacity to display all their products, attracting more customers. In that sense visibility affects the amount area they occupy.

5.5. Recommendations

This section briefly summarizes the key insights of the study as general recommendations that urban planners and designers could consider for future development of street vending ordering plans and strategies in the area of Mercado Central and Mesa Redonda.

- **Balancing the distribution of pedestrian activities**: since the concentration of street vendors is driven by the high pedestrian movement in jr. Andahuaylas, the better distribution of street vendors in the area, should be accompanied by strategies to attract foot traffic to alternative areas.

- **Formalization of opportunity space**: In shared and vehicular streets, prioritize the use of underutilized parking areas for street vendors by designating specific spaces. In pedestrian streets, formalize the use of carriage lanes by establishing timeframes for their use by street vendors and carriers, ensuring an organized and efficient allocation of space.

- **Integration of stationary vendors to pedestrian streets**: prioritize the allocation of stationary street vendors in the opportunity space of pedestrian streets and address their spatial needs through the design of compact modules that maximize product visibility while minimizing space occupation.

- **Adapting pavements for vending and pedestrians**: where street scale allows it, expand sidewalks to meet the recommended width for integrating street vending. In cases where expansion is not feasible, consider redesign of pedestrian streets into single-level platforms that eliminate traditional sidewalk, allowing for a more flexible accommodation of street vending while maintaining smooth pedestrian flows

- **Street intersections as social spaces for street food vending**: prioritize the use of intersections for street food vending and redesign corners to accommodate their operations, considering their spatial requirements and the social interactions they foster.

- **Integrate retail in the allocation of street vending:** allocate stationary vendors based on their products to streets where they can complement the existing retail offerings. In retail areas, design compact setups for small-scale mobile vendors to accommodate them in the pavement between storefronts without obstructing pedestrians.

- **Support vending with pedestrian-friendly vehicular streets**: Promote noise- and smoke-free vehicular streets with low-speed limits, and avoid placing parking spaces for cars and motorcycles near areas designated for street vendors, ensuring their visibility is not obstructed and pedestrian-friendly environments are maintained.

- **Greenery for public spaces**: where possible, incorporate trees along streets to provide shade and shelter for vendors, while also improving air quality in areas with high activity density, enhancing both the comfort of street vendors and the overall public space environment.

- **Activation of blind walls through street vending**: in pedestrian streets, accommodate street vendors along blind walls to enhance the vibrancy of the environment, utilizing otherwise unused space.

6. Conclusions and Outlook

The purpose of this research was to firstly identify which variables from the built environment could influence the spatial behavior patterns of street vending. Building on those results, the second aim was to understand how and to what extent these variables influence the spatial behavior patterns of street vending. This goal was presented in five hypotheses. In this chapter, these hypotheses are revisited to see the extent to which they have been addressed.

6.1. Key findings and conclusions

Overall, the study found that while the built environment influences street vending to a certain degree, the most decisive factors in their spatial distribution are pedestrian traffic and municipal surveillance. Street vendors strongly prioritize the economic benefits of high pedestrian movement over spatial conditions, adapting their operations and spatial occupations to high-foot-traffic areas. In contrast, low pedestrian movement and active municipal surveillance are the two most discouraging factors for their location. Although the built environment's influence appeared relatively lower compared to pedestrian traffic and municipal surveillance, the study provided valuable insights not only into how smaller-scale spatial characteristics shape vendors' location choices, but also how these factors impact their working conditions.

Hypothesis 1*: Overall, street vendors tend to be more densely located in pedestrian-only streets, while they avoid streets prioritizing motorized-vehicles.*

As expected, **street functionality** has a strong influence in the spatial distribution of street vendors in the study area. As previous studies found (Sun, Scott, Bell, Yang, & Yang, 2022), across all vendor types, there is a strong preference for only-pedestrian streets, mainly because of the access to consistent pedestrian flows, the availability of space and the absence of vehicular traffic, which hinders their interactions with passers-by and negatively impact their working conditions with noise and air pollution. Stationary vendors operating with floor mats, hangers, and tables, are the most vulnerable to cars and they are almost only compatible with pedestrian streets, given their broader spatial requirements. On the other hand, semi stationary and mobile vendors, such as mobile kiosks, trolleys and tricycles, use more compact and mobility-flexible set ups that can adapt to the spatial constraints of vehicular roads, benefiting from selling mostly food and drinks to drivers, as mentioned by Farouk (2019) in his study of street vending in terminals in Cairo.

Hypothesis 2*: Overall, street vendors tend to be more densely located on streets or side of the street with a higher concentration of retail entrances.*

Contrary to common assumptions and the findings of Peimani and Kamalipour (2024), the computational analysis revealed a weak correlation between **retail entrance density** and street vending density. This outcome is largely due a stronger influence of pedestrian movement and municipal surveillance. While street vending in the study site is often

concentrated in high retail density areas, since retail attracts more pedestrians, the observational analysis and interviews suggest a nuanced relationship. Although retail is often associated with high pedestrian movement and, consequently, higher street vending density, certain streets connecting key urban nodes experience high foot traffic regardless of retail presence.
Further observational data revealed that mobile vendors, particularly those using small trolleys and kiosks, are more likely to position themselves on the pavement directly adjacent to retail entrances to benefit from customer flow. This finding aligns with Urvashi and Mayuresh (2024), who highlighted the influence of frontage plot length on street vending patterns. In contrast, stationary vendors, such as those operating with hangers and tables, do not employ this strategy due to their larger spatial requirements. Vendors using mat floors are also less likely to do so, as their setup is more vulnerable to the disruptions caused by high foot traffic. However, stationary vendors often benefit from positioning themselves along streets where shops sell complementary or similar products.

Hypothesis 3*: While pavement width does not significantly influence street vendors´ location choice, street vendors are more likely to occupy wider pavements.*

As anticipated, the statistical and qualitative studies confirmed that **pavement width** is not a significant variable influencing street vendors´ distribution in the study area. However, it was also revealed that street vendors are only slightly more inclined to occupy wider pavements. The research showed that this is because street vendors prefer to use the opportunity space when it is available, regardless of the pavement width. Furthermore, it was found that 70% of the pavements in the study area do not meet the advised width to accommodate street vending setups and pedestrian traffic, which could also explain their preference for the opportunity space. This finding challenges the general assumption that street vendors occupy pavements without considering accessibility for pedestrians, and aligns with Swai (2019) as he observed that vendors organically tend to position themselves in ways that do not obstruct pedestrian movement. Furthermore, when considering vendor setups, mobile kiosks are the most suitable option for street vending on pavements due to their compact design, which facilitates efficient use of space while ensuring smooth pedestrian movement.

***Hypothesis* 4**: *Street vendors tend to be more densely located in areas with opportunity space, and as the area of opportunity space in a street increase, vendors tend to occupy less of the pavement.*

The statistical and observational analysis revealed a weak relationship between the availability of **opportunity space** and street vending density, primarily due to the stronger influence of pedestrian flows, municipality surveillance, and functional type of the street. Similarly, the results for the statistical analysis showed a weak negative correlation between opportunity space availability and pavement occupation density. However, the observational study indicated that these results were also affected by other factors, such as the overall scarcity of street vendors in vehicular areas with low pedestrian traffic. When examining occupation patterns at a street level, it was consistently observed that street vendors prioritize the occupation of opportunity space when it is available, regardless of the pavement width, particularly vendors operating

with hangers and tables. This finding supports the observations from Jwalant, Urvashi, and Mayuresh (2024) about the attractivenes of parking spaces because of their potential as extension or operating areas for vendors.
The study also revealed that the preference for opportunity space is based by several factors: avoiding obstruction of pedestrian flows, taking advantage of customer movement on both sides in pedestrian-only streets, and benefiting from greater spatial flexibility, as these areas are not constrained by storefronts like pavements are. However, the interviews and observations also indicated a key disadvantage of opportunity spaces. In the case of underused parking, there is a risk of cars or motorcycles may use the space, which can obstruct vendors' visibility and space flexibility. In the case of carriage lanes, when vendors occupy these areas, it forces carriers to move through pedestrian leading to congestion and disruption of the interactions with passers-by.

***Hypothesis* 5**: *Street vendors tend to be more densely located in highly visible areas.*

The results revealed that, overall, visibility is not a determining factor in the spatial distribution of street vendors, as areas with high pedestrian flow offer greater customer proximity than highly visible locations. Moreover, the findings support the observations from Peimani and Kamalipour (2024) about highly visibility places increasing the risk of detection by authorities, as the most visible areas in the study site were often under municipal surveillance, which discouraged vendors from occupying these spaces.
However, as Swai (2019) findings in Dar es Salaam city, the qualitative analysis found that there is a consistent relationship between street-food vendors and highly visible spaces, these being street intersections. The observations showed that corners in less densely occupied areas, create a favorable environment for street-food vendors in terms of customer exposure and spatial conditions.
In contrast, the qualitative analysis supports the observations from Peimani & Kamalipour (2024), by showing that in high-foot traffic areas, visibility does not depend on the environment, but in the capacity to advertise goods. In the case of jr. Andahuaylas vendors occupy large areas of the street to display all their goods.

Other valuable insights include the necessity of **shade** and the **negative impacts of carriers**. While street vendors in the area provide their own shade using umbrellas, during the interviews the vast majority of respondents emphasized its importance, as heat significantly impacts their working conditions. Furthermore, observations showed that although trees are scarce in the area, vendors consistently prefer locations under trees when available. The interviews also showed that a major cause of pedestrian congestion and discomfort for street vendors is the presence of carriers, whose use of space obstructs vendor-customer interactions.

6.2. Limitations of the study

While this study provides valuable insights into the spatial behavior patterns of street vendors in the historic center of Lima, several limitations of the study must be acknowledged, which are mainly related to the data gathering, methodological constraints and the complexity of urban informal economies.

Regarding data collection, the study relies on video recordings taken within a specific timeframe, which does not capture the variations on street vending distribution across different times of the day, days of the week, or seasonal changes. Furthermore, street vending is a highly dynamic activity, and vendors may adjust their locations based on weather conditions, municipal regulations and enforcement, or economic necessities.
Moreover, the data collection methodology, based in manual counting's, is more prone to inaccuracies. Data gathering based on computational recognition of vendors using high resolution imagery, could improve the reliability of the results.

The research primarily focuses on the built environment variables influencing street vending spatial patterns. However, there are other factors that have stronger explanatory power, such as pedestrian movement, municipal enforcements, informal governance structures, economic pressures, and social networks among street vendors. Regarding pedestrian traffic, the lack of precise information or a movement model, presents a challenge to determine the extent of the influence of the built environment variables.

The focus on a single case study, presents a limitation to generalize the results to other contexts. The findings from this research are context specific to the historic center of Lima.

6.3. Future research

This study provides valuable insights into the spatial distribution of street vendors in Lima and their relationship with the built environment. However given the complexity of urban informal economies, several areas need further research.

Future studies could include time and identify how vending patterns change over days, weeks or seasonal festivities, particularly in the study area, where festivities increase the amount of street vendors. This would result in wider and more precise insights for urban planners and designers.

Another possibility is to use this methodology to do a comparative study in different contexts, including areas with varying densities, land uses, commercial activity, and levels of regulation. This would allow to identify if similar relationships between vendors spatial behavior and the built environment hold across different contexts. Furthermore, it could bring valuable insights into how the spatial patterns change depending on the cultural and social background.

Further research could also build up on the insights of this study to create a suitability indicator in public spaces for street vending. The study could include not only the built environment variables, but also economic, social and regulatory frameworks factors to identify suitable spaces for commercial activities in the streets. Moreover, different design strategies for integrating street vendors into the public space can be tested.

6.4. Conclusion

Overall, the study highlights the complexity of street vending spatial patterns and emphasizes the need for a more detailed, street-scale approach to urban planning. The findings provide valuable information for local urban planners and designers to consider when developing a street vending ordering strategy for the Historic Center of Lima.
Rather than prioritizing relocation, urban regulations should integrate considerations such as appropriate pavement width, pedestrianization strategy that consciously accommodate street vending, the formalization and thoughtful design of underutilized parking areas as designated spaces for street vendors, proximity to retail, and the activation of blind walls through vendors. Additionally, policies should recognize the diversity of vendors and formalize their setups based on their products and identifying suitable locations that align with their spatial and economic needs.
By acknowledging the relationship between the built environment and street vending, city planners can develop strategies that foster more inclusive urban spaces for informal economies, while maintaining the quality and functionality of public spaces.

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Appendices

1. Expert consultation survey

Introduction

Thank you for taking the time to participate in this survey. This survey is part of my master's thesis research for the **M.Sc. Integrated Urban Development and Design** program at Bauhaus-Universität Weimar. The study examines **how the built environment influences the spatial behavior of street vendors**, focusing on the area around Mercado Central and Mesa Redonda in Lima's historic center.

As part of the research methodology, this survey aims to refine key built environment variables (extracted from literature review) that affect street vending patterns, drawing on insights from experts. Your input is invaluable to ensuring the accuracy and relevance of this analysis.

The survey should take approximately **10-15 minutes** to complete. Your response will remain confidential and will be used solely for academic purposes.

Section 1: Participant Information (Optional)

1. Name: Haga clic o pulse aquí para escribir texto.
2. Professional Role/ Title: Haga clic o pulse aquí para escribir texto.
3. Years of experience: Haga clic o pulse aquí para escribir texto.
4. Areas of Expertise:

   ☐Urban Design

   ☐Urban Planning

   ☐Informal Economy

   ☐Sociology

   ☐Others: Haga clic o pulse aquí para escribir texto.

Section 2: Variables importance

Instructions: Below are built environment variables from the city and street scales identified through literature review. For each, please:

1. Rate its influence on street vending spatial behavior
   (1= Not influential, 5 = Highly influential)
2. Provide comments or examples to elaborate **(optional)**

City Scale

Variable	Influence 1= Not influential 5 = Highly influential					Comments or example
	1	2	3	4	5	
Proximity to Markets and commercial areas	☐	☐	☐	☐	☐	
Proximity to public transport stops and stations	☐	☐	☐	☐	☐	
Proximity to other facilities *(Educational, health, recreational, cultural, religious, etc.)*	☐	☐	☐	☐	☐	
Functional Mix *(Coexistence of different land uses within a city.)*	☐	☐	☐	☐	☐	
Street hierarchy *(Arterial, collector and local streets.)*	☐	☐	☐	☐	☐	
Street network centrality *(How well connected is a street to other parts of the network.)*	☐	☐	☐	☐	☐	

Street scale

Variable	Influence 1= Not influential 5 = Highly influential					Comments or example
	1	2	3	4	5	
Greenery	☐	☐	☐	☐	☐	
Pavement width	☐	☐	☐	☐	☐	
Street lighting	☐	☐	☐	☐	☐	
Spatial openness	☐	☐	☐	☐	☐	
Pedestrian priority of the streets	☐	☐	☐	☐	☐	
Functional mix *(diversity of uses in a block or street)*	☐	☐	☐	☐	☐	
Shadow availability	☐	☐	☐	☐	☐	
Retail entrance density *(Groundfloor storefronts including entrances and large display windows.)*	☐	☐	☐	☐	☐	
Opportunity Space availability *(Underused or extra space in a street such as under used car parking and wide pavements.)*	☐	☐	☐	☐	☐	
Visibility *(The degree to which an environment provides unobstructed visual access across a space.)*	☐	☐	☐	☐	☐	

Section 3: Open – Ended Questions

1. Are there any additional built environment variables you believe influence street vending that are not listed above?
2. Are there specific aspects of the built environment in the area of Mercado Central and Mesa Redonda that you think are particularly important to consider?
3. Do you have any recommendations for further refining these variables or incorporating contextual factors?

Conclusion

Thank you for your participation. If you would like to receive a summary of the findings or discuss the results further, please provide your email address: Haga clic o pulse aquí para escribir texto.

2. Semi-structured interview to street vendors

Semi-Structured Interview Guide for Street Vendors

Introduction:

- *I am conducting research on street vending in the Mercado Central and Mesa Redonda areas to understand how the urban environment influences where and how vendors work.*
- *This interview will take approximately 5 minutes. Your answers will be anonymous, and you may skip any question you are not comfortable with.*
- *May I have your permission to record this conversation for research purposes?*

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1. General Information

1. What type of products do you sell?
2. What led you to choose this particular location for your sales, and what are its advantages?
3. Do you change locations throughout the day or week? If so, what motivates you to do so?

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2. Urban Space and Vendor Behavior

1. How does the physical space around you affect your work?
2. Does the width of the sidewalk influence your location choice or affect your work in any way? Why?
3. Does the availability of shadow in the urban environment (such as trees) influence your location choice or affect your work in any way? How?
4. Is the proximity to store entrances important for your location choice or does it affect your work in any way? How?
5. Does the availability of extra space on the street (such as parking or carriage areas) influence your location choice or affect your work in any way? How?
6. Does the visibility of your location affect your work? (For example, if it is too hidden or too exposed) Do you prefer corners or streets?
7. Do you think the type of street where you work (pedestrian or with vehicle traffic) influences your sales or comfort?

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3. Other Influencing Factors

12. Besides the physical space, what other factors influence your location? (For example, restrictions, police presence, competition, relationships with stores)

13. If you could change something about the urban environment here to improve your working conditions, what would it be?

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Signature (First name and Surname)