The reasons for a decline in pedestrian traffic when moving from the CBD-core towards its periphery

Luna Pestotnik Stres

Stres Inženiring d.o.o.

Tip publikacije: Monografska publikacija
Naslov: The reasons for a decline in the pedestrian traffic when moving from the CBD-core towards its periphery
Avtor: Luna Pestotnik Stres
Leto izdaje: 2025
Jezik: angleški
Država izdaje: Slovenija
Kraj izdaje: Tolmin
Založnik: Stres Inženiring d.o.o.
Format: PDF
URL: https://stres-apartments.eu/books/monografija_GEO.pdf

CIP:
Kataložni zapis o publikaciji (CIP) pripravili v Narodni in univerzitetni knjižnici v Ljubljani
COBISS.SI-ID 247649283
ISBN 978-961-93233-4-2 (PDF)

Extract

Cities reveal their structure not only through buildings and streets, but through the flow of people who inhabit them. In Ljubljana, the heart of the central business district (CBD) pulses with dense pedestrian activity, while each step towards the periphery brings a gradual thinning of movement. This work explores the factors behind that pattern, showing how commercial concentration, accessibility, and vertical zoning sustain the bustle of the core, while distance reduces its intensity. By tracing the rhythm of footsteps from center to edge, the study offers insight into how urban space shapes human presence and experience.

Table of Contents

1. INTRODUCTION

1.1 FIELDWORK QUESTION

"What are the reasons for a decline in pedestrian traffic when moving from the CBD-core towards its periphery?"

1.2 GEOGRAPHICAL CONTEXT

Ljubljana is the capital of Slovenia, a small country in Central Europe (Figures 1 and 2). It has a population of 285.604 people (2021) ("*Data on population").* Together with the hinterland, Ljubljana generates approximately one-third of the gross domestic product (GDP) ("*The region").* It is the biggest city in the country, offering career opportunities, a well-organised transport system, a lively cultural scene, diverse historical buildings and tourist attractions.

Figure 1: Position of Slovenia in Europe (source: OSM, digitally annotated)

Figure 2: Position of Ljubljana in Slovenia (source: OSM, digitally annotated)

Most business, commercial and tourist activities in Ljubljana occur in the Central district -the Centre-, which extends over approximately 5 km^2. However, because this is a large area, this investigation chooses Tomšičeva Street 2, the location of the oldest department store in Ljubljana, Nama (Figure 3), as the CBD-core.

Figure 3: Nama, (personal archive)

The Centre extends (Figure 4) into **Čopova Street** ("*Čopova ulica*"), a 187-meter, highly commercial passage that connects the CBD-core and pedestrian zone, stretching beneath Castle Hill.

From Čopova Street, this zone continues through the **City Square** and the **Old Square**, both approximately 200-meter-long lanes ("*Google Maps*"). Here, the landscape transitions from commercial to residential area.

The Centre ends with the **Upper Square**, a 300-meter alley known for its quiet location. At its end, the urban structure changes significantly. A busy road and a tunnel create a natural boundary, terminating the Centre's residential zone. Therefore, the Upper Square is defined as the CBD periphery.

All four areas (Čopova Street, City, Old and Upper Squares) are analysed using urban structure model elements to determine how the pedestrian traffic changes with distance from the CBD-core.

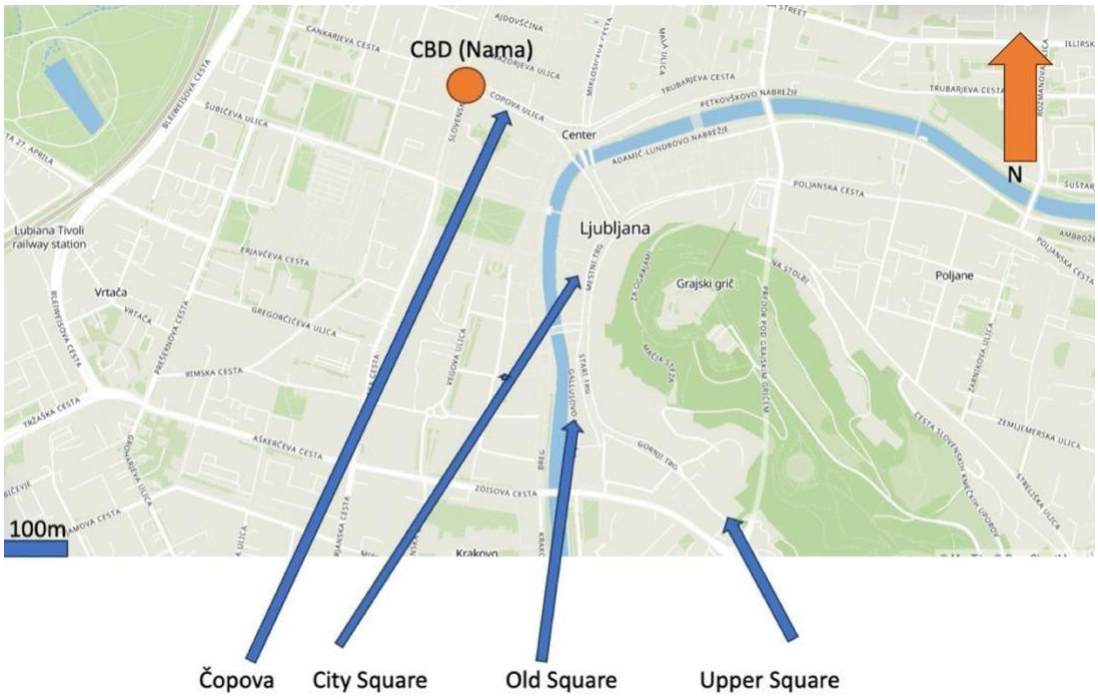

Figure 4: Location of four analysed areas, Čopova street, City square, Old square, Upper square (source: OSM, digitally annotated)

1.3 HYPOTHESIS

The following hypotheses are formed:

1. Pedestrian traffic **decreases with distance from the CBD-core**, as commercial areas attract more people than the quieter parts of the CBD periphery. Thus, Čopova Street is expected to experience the highest pedestrian traffic, followed by City, Old, and Upper Square.
2. Pedestrian traffic trends are consistent with the **bid-rent theory** ("*Bid-rent theory*") governing **land use**, allowing lucrative brands to secure prime locations. Thus, a decrease in foreign and increase in local shops, and a multiplication of residential buildings is expected with growing distance from the CBD-core.

3. Pedestrian traffic trends are linked to **vertical zoning**, which is characterised by taller buildings with multiple functions and a concentration of services within a limited area. As a consequence of vertical zoning, the highest pedestrian traffic is expected closest to the CBD-core, and is decreasing with diminishing vertical zoning effect.
4. **Public transport and the proximity to tourist attractions** influence pedestrian traffic. More accessible routes to their desired destinations positively correlate to pedestrian (both domestic and tourists) traffic.

2. METHODOLOGY OF THE INVESTIGATION

The primary data were obtained during the fieldwork as part of the IB Geography and refer to the four areas: Čopova Street, City, Old, and Upper Squares. The observations took place on two sunny, early afternoons in June and September 2024.

The **number of pedestrians** passing the middle of each analysed area over a 10-minute-period was recorded to confirm the first hypothesis. Pedestrians were counted separately for those heading towards the CBD (Nama) and those coming from the CBD (Figure 5).

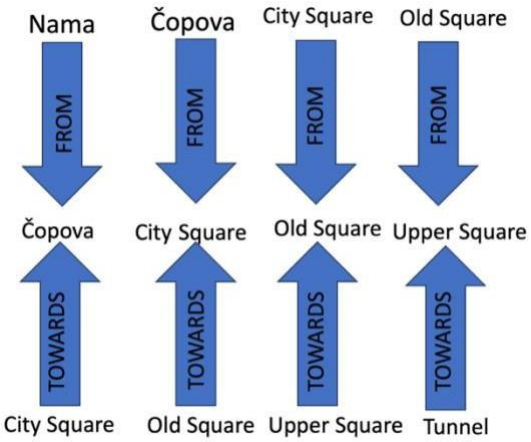

Figure 5: The pedestrian flow directions (digitally created)

The influence of **land use** on pedestrian traffic trends were also analysed: buildings within the investigated areas were observed, and each was assigned a function using Table 1. If a building served multiple functions, all were attributed to it. The results were linked to the bid-rent theory to explore whether it is reflected in land use and, consequently, in pedestrian traffic patterns. Accommodation prices ("*Booking.com*") in different areas were compared to confirm the applicability of the bid-rent theory.

Table 1: Urban functions and their corresponding abbreviations

Urban Function	In further text
Specialist shops-local	Local
Specialist shops- foreign	Foreign
Coffees, restaurants	Cafes
Hotels, Apartments	Hotels
Public buildings- church, school	Public
Empty buildings	Empty
Residential	Residential

To evaluate the third hypothesis, buildings' height was determined by counting the number of floors, excluding the ground floor. These data was used to calculate each area's central business height index.

Walking time from each area to the top five visited ("*Ljubljana attractions*") Ljubljana attractions were determined to evaluate the attraction proximity effect. Furthermore, distances to the nearest bus stops and their connectivity were analysed in relation to the pedestrian traffic.

3. RESULTS AND ANALYSIS

3.1 PEDESTRIAN COUNT

The number of pedestrians counted is presented in Table 2 and Figure 6.

Table 2: Pedestrian counts

Direction with respect to CBD	**June**	**September**	**Average**	**Total**
Čopova Street				
Towards	334	332	333	
From	224	290	257	590
City Square				
Towards	83	85	84	
From	114	229	171.5	255.5
Old Square				
Towards	79	77	78	
From	151	142	146.5	224.5
Upper Square				
Towards	27	21	24	
From	31	31	31	55

The data for June and September show no significant change in pedestrian traffic numbers, suggesting that both months are in the same stage of the tourist season.

Aside from the section of Čopova Street, the preferred direction for pedestrians is from the CBD-core, influenced by the time of day when people are heading home.

The most significant contrast between the numbers of pedestrians heading towards and from is observed at the Old Square, where for every person walking towards the CBD, two are walking away.

A decreasing trend in pedestrian traffic is observed as one moves further from the CBD. The number of pedestrians counted on Čopova Street is approximately 10:1 compared to Upper Square. The decrease is non-linear; pedestrian traffic at Old and City Squars is roughly equal, suggesting no significant redirection of pedestrians between them.

Figure 6: Counted number of pedestrians

3.2 LAND USE AND BID-RENT THEORY

The bid-rent theory indicates a negative correlation between land value and distance from the CBD. Čopova Street is situated in the core of the CBD, contributing to its elevated land value. This is further emphasised by the fact that the area is the smallest, resulting in high demand for limited land. The practical application of the bid-rent theory is demonstrated by comparing the accommodation prices of four differently located accommodations on Booking.com (Figure 7). The apartments possess approximately the same ratings to eliminate the influence of attractiveness on their prices.

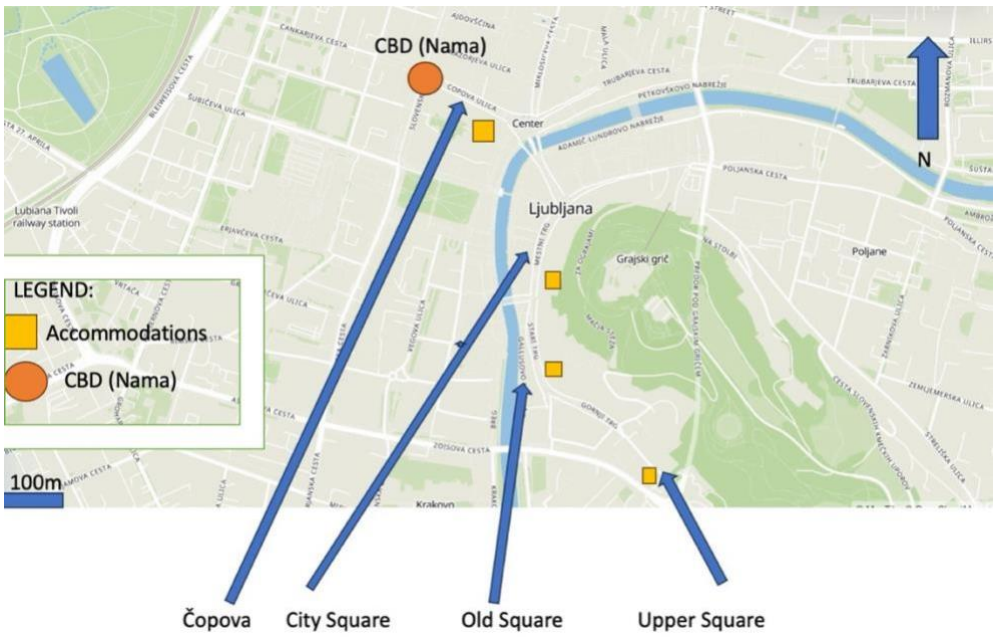

Figure 7: The location of four apartments in different parts of the city Centre (source: OSM, digitally annotated)

An accommodation price decrease is observed with increasing distance from the CBD (Table 3). The apartment on Čopova Street is found to be more than 100% more expensive, despite

being the smallest of the presented apartments. This indicates that location affects the price more than the size of the apartment.

Table 3: Accommodation price

Location	Price/night	Size (m2)	Rating	Price/m2
Čopova Street	256	58	9.8	4.41
City Square	210	70	9.4	3
Old Square	196	75	9.6	2.61
Upper Square	112	90	9.1	1.24

To demonstrate the influence of location on accommodation prices, these are converted to price per square metre and presented in Figure 8.

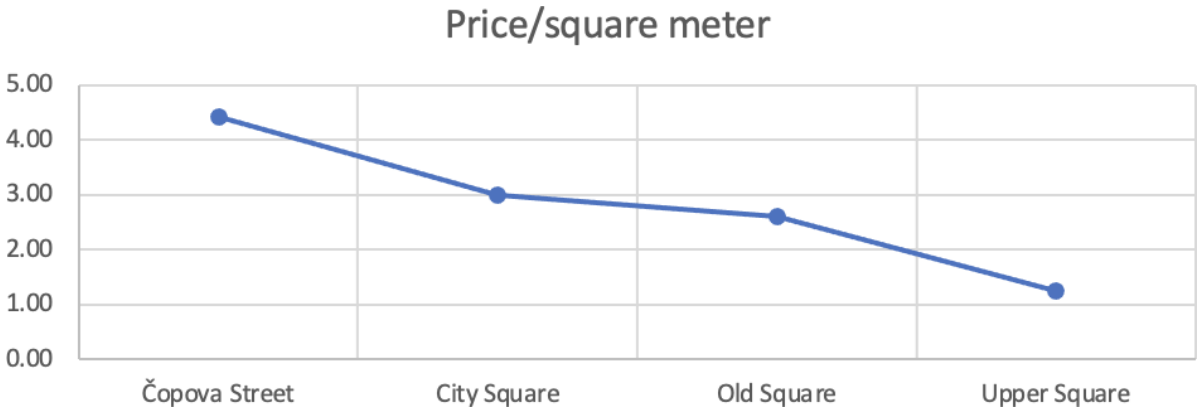

Figure 8: Price of the Booking.com accommodations per square meter with reference to the CBD distance

In addition, the land use mapping is performed (Figure 9) and its results are shown in Table 4.

Table 4: Number of buildings with specific urban function by area (dark green the prevailing)

Urban Function	Čopova Street	City Square	Old Square	Upper Square
Local	2	10	17	13
Foreign	12	9	6	2
Cafes	4	5	12	4
Hotels	3	0	0	3
Public	4	3	3	2
Empty	3	1	3	2
Residential	0	19	25	33

Figure 9:Land use for the chosen areas

The observed trend aligns with the bid-rent theory. The companies willing to pay the most are positioned mainly in the CBD-core, where their sales prospects are increased.

Čopova Street showcases a high concentration of retail stores (43% of all land functions), the majority of which are foreign (12 out of 14). For these businesses, a location with high pedestrian traffic is vital. By positioning themselves in desirable, accessible locations, they attract people from the vicinity and the outskirts, where such goods are unavailable. This creates a positive feedback-loop between popular stores and pedestrian traffic; they situate themselves in areas with high pedestrian traffic and, in turn, generate even more pedestrian traffic. Observed land use reflects high competition and results in only a small proportion of cafes (4) and hotels (3), with no residential homes in this area.

When moving away from the CBD-core, the trend shifts. The prevailing functions become the cafes and local stores (10 City Square, 17 Old Square, 13 Upper Square), thriving on uniqueness, personalised customer service, and high quality. With specialty shops demand

decreases, leading to a reduction in pedestrian traffic. Furthermore, there is a noticeable rise in residential homes (19 City Square, 25 Old Square, 33 Upper Square), further diminishing pedestrian traffic, as these areas offer fewer amenities and services. Lastly, the trend remains unchanged for public buildings and hotels, indicating their random distribution across various distances from the CBD-core.

3.3 VERTICAL ZONING

The height of the buildings can be measured by floor counting (Figure 10), as well as the Central Business Height Index (CBHI) calculations, denoting the average height of buildings in an area. This fieldwork focused on the number of floors in each building; the calculations are slightly modified and utilise the following equation:

$$h_{avg} = \frac{Number\ of\ storeys}{Number\ of\ buildings}$$

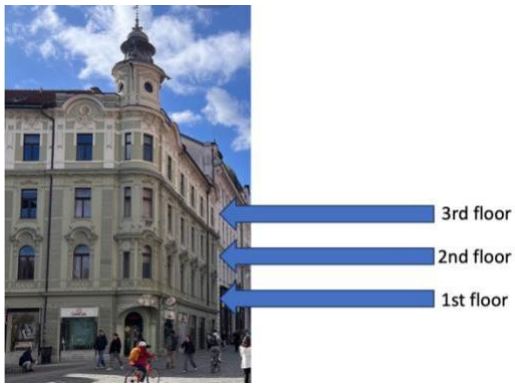

Figure 10: Floor level depicted (source: personal archive)

The area's CBHI and the floor mode, defined as the number of floors most commonly found in each area, are presented in Table 5:

Table 5: Number of floors and CBHI values

	Number of buildings			
	Čopova Street	City Square	Old Square	Upper Square
Floor mode	4	3	2	2
CBHI	3.38	3.33	2.24	2.49

The dominant floor mode decreases with CBD-core distance. From location right next to the CBD-Čopova Street- with floor mode four, the floor mode diminishes to three for City Square and two for Old and Upper Squares.

The CBHI calculations exhibit the same trend. Comparing the innermost and outermost locations in relation to the CBD, the Čopova Street is almost an entire floor higher than the Upper Square, gathering more services in a smaller area. The decrease is not linear (Figure 11). The building CBHI is higher for the Old Square than for the Upper Square, most likely as a result of random historical building height variations.

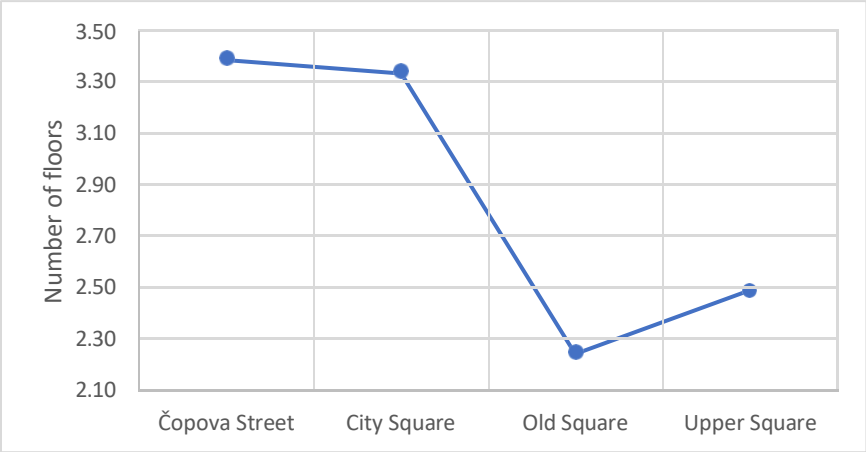

Figure 11: CBHI index

Comparing Figures 6 and 11, taller buildings reflect increased pedestrian traffic. Two reasons contribute to this.
Firstly, taller buildings result in a broader range of services concentrated on a smaller area, making the area more commercially attractive for consumers.
Secondly, vertical zoning facilitates the development of multiple services clustered within the same building (offices occupy the upper and commercial activities the lower floors), also increasing the employee demand, additionaly increasing pedestrian traffic while commuting to their workplaces.
In comparison, the reduced height of buildings in other areas is linked to diminished services, a rise in the number of residential buildings and a decline in pedestrian traffic.

3.4 PUBLIC TRANSPORT

Ljubljana is considered accessible due to bus lines and stations across its centre (Figure 12).

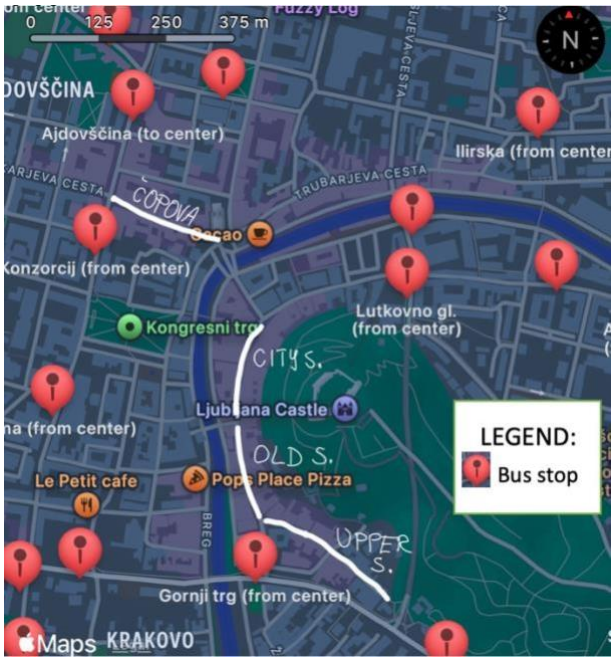

Figure 12: The proximity of the transport stations (source: Apple Maps)

However, the analysed areas are all pedestrian paths, and their distances to the nearest bus stations vary, as seen in Table 6:

Table 6: Nearest bus stations, their distances and connectivities

ANALYSED AREA	BUS STATION	DISTANCE TO THE STATION	N. OF BUS LINES PASSING THROUGH	LINE NAMES
ČOPOVA STREET	Konzorcij	210m	11	1B,2,3,3G,6,6B,9,14, 18,19B, 27
CITY SQUARE	Lutkovno gl.	350m	1	2
OLD SQUARE	Gornji Trg	240m	6	2, 3, 3G, 11, 19B, 27
UPPER SQUARE	Gornji Trg	220m	6	2, 3, 3G, 11, 19B, 27

The shortest distance to the bus station is from Čopova Street, and the longest is from the City Square. However, as distances are approximately the same for practical use, the accessibility of different bus lines at the bus stations plays a bigger role.

For Čopova Street, the nearest corresponding station offers higher buss-routes accessibility, as 11 out of 34 city bus lines pass through it. The frequent bus services connect most parts of Ljubljana with Čopova Street, making it an ideal entry point for tourists visiting the city centre and locals enjoying leisure facilities in Ljubljana's centre. The pedestrian traffic in the CBD-core on Čopova Street is therefore increased due to easily accessible public transport.

On the other hand, the reduced pedestrian traffic in other analysed areas can be partially attributed to lower public transport accessibility. The corresponding bus stations serve only a smaller proportion of bus lines (for instance, the bus station nearest to the City Square – Lutkovno gl. –serves only one line). Consequently, people may opt to walk to the Konzorcij bus station with higher bus-route accessibility, which reduces pedestrian traffic in the areas considered.

3.5 THE INFLUENCE OF TOURISM

As Ljubljana is considered a popular tourist attraction, the contributions of tourists to pedestrian traffic, especially in months such as June and September, are important. Therefore, the top five tourist attractions and their walking times to the analysed areas are determined. The locations of each attraction can be observed in Figure 13, and the results in Figure 14.

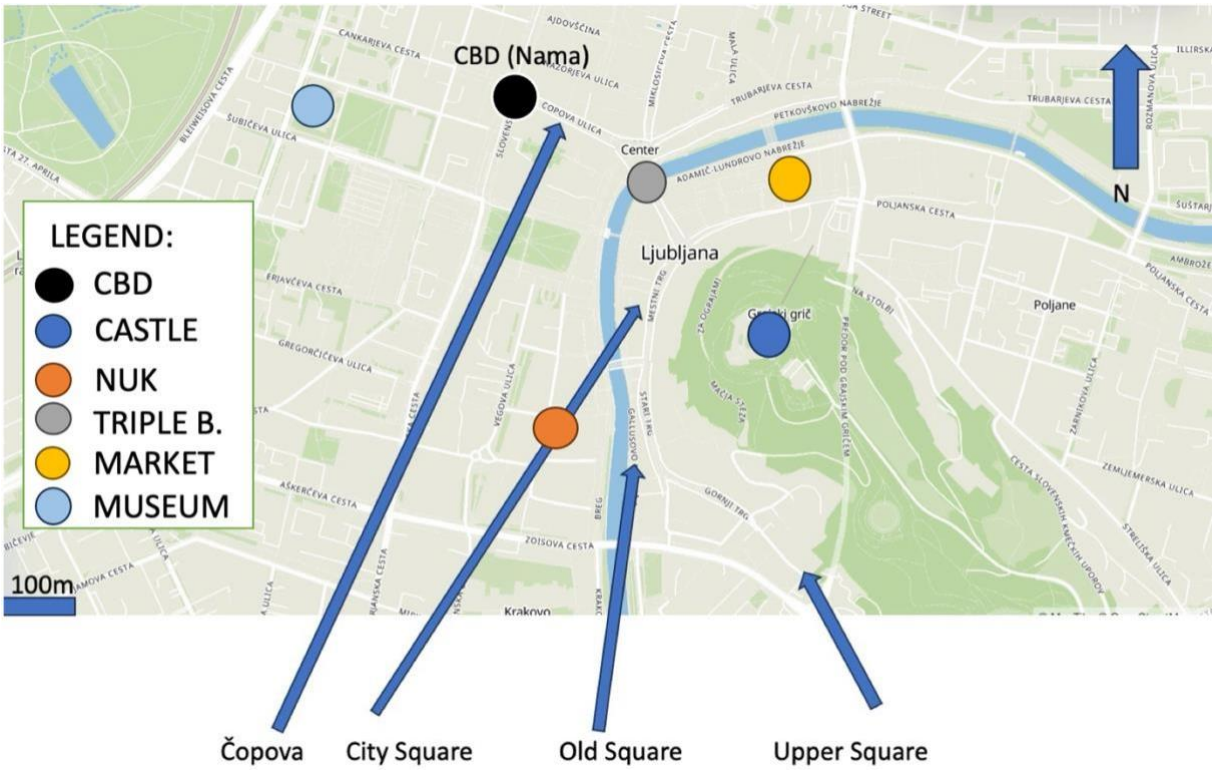

Figure 13: Top 5 attractions located relative to the CBD-core (source: OSM, digitally annotated)

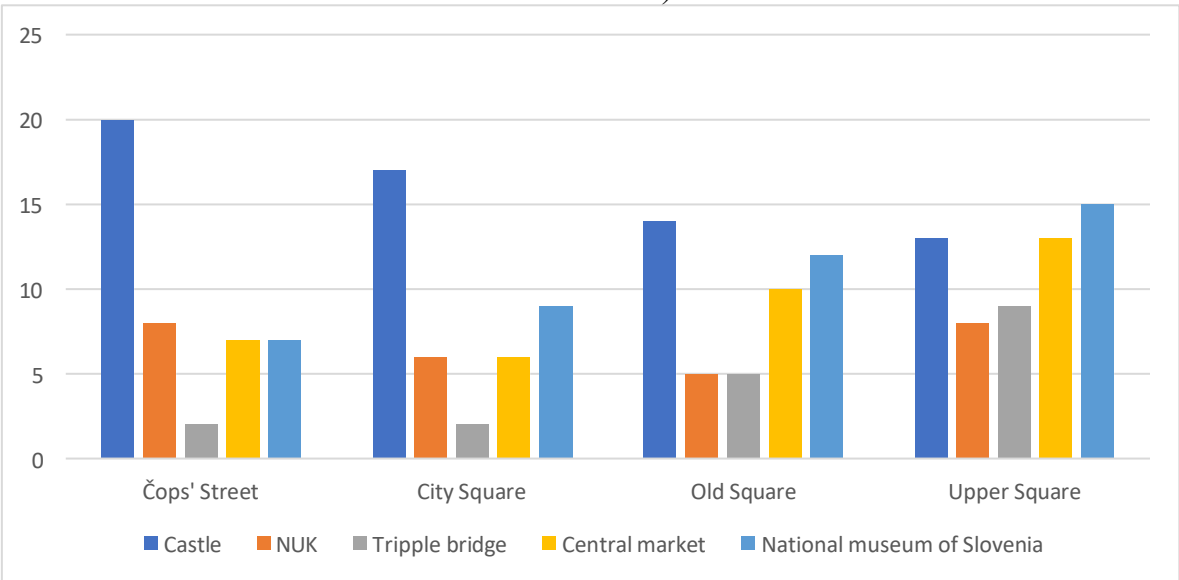

Figure 14: Walking times to top 5 attractions in minutes

The distances to the attractions vary, and no single area corresponds to the shortest time for all. However, it is deduced that with distance from CBD, the time towards the Ljubljana Castle decreases, while it increases for all other attractions.

The attractions are all historical sites and were constructed independently of the CBD. Therefore, the pedestrian traffic is not necessarily influenced by tourists, as they are most likely to gather in the areas with minimal walking times to them, which, as shown (Figure 14), do not all correspond to the CBD-core. Even so, one tourist attraction (The triple bridges) is located right next to Čopova Street, thus increasing the traffic in this area.

4. EVALUATION

This investigation could have been improved in many ways. Firstly, all the measurements, despite being taken in two different months, were obtained at the peak of Ljubljana's touristic season. To successfully analyse the contribution to the pedestrian trends from touristic activities, the comparison of results from a non-touristic month and a touristic month should be made.
Next, the observations were recorded only twice, not providing sufficient statistics about the true trends in pedestrian traffic as systematic (to us unknown) errors were potentially recorded and led to deviations of the results.
Moreover, the measurements were conducted in the early afternoon. If the traffic flow was considered as a time-dependent system, the observations should have been noted at different times in a day. This could also explain the reasons for the opposing prevailing directions in pedestrian traffic on Čopova versus the rest of the observed areas.
Even so, this investigation hold some strenghts.
The location was appropriately chosen. CBD-core could easily be distinguished from its periphery, providing a baseline for effective comparison. Secondly, the fieldwork was thoroughly conducted. Each building was observed separately so that its urban function and the number of floors were identified. Lastly, the analysis was approached from different perspectives when seeking the reasons for observed trends. This led to greater objectivity when interpreting the results.
If this investigation was conducted again, it could also be expanded to include a larger area so to observe trends on a greater scale.

5. CONCLUSION

Firstly, counting the pedestrians through specific areas confirmed the hypothesis that the pedestrian traffic decreases with distance from the CBD-core.
The land use mapping suggested that the CBD-core mainly locates foreign brands, striving on massive sales and depending on customers. Conversely, consumers are attracted to accessible foreign stores, increasing pedestrian traffic. This results in a positive feedback loop between the foreign brands and the pedestrian traffic.
As the competition is high, only the most lucrative brands can afford a location in the CBD-core. Thus, local specialist shops and cafes are primarily positioned in quieter parts towards the CBD periphery (City, Old, Upper Squares), where they can focus on individualised service. Consequently, the number of pedestrians decreases with CBD-core distance, which is amplyfied by the increase in residential homes. The second hypothesis was also confirmed.
The exhibited land use is consistent with the bid-rent theory, where its validity was validated also with accommodation price trends.
Secondly, vertical zoning influences pedestrian traffic in two ways. In the places where the buildings are higher (CBD-core- Čopova Street), services are condensed on a smaller area, increasing the pedestrian density. Also, more services provide more jobs, so employees contribute to the traffic. On the other hand, distance from the CBD-core reduces building height and also pedestrian traffic.
Moreover, due to greater accessibility, Čopova Street serves as a vital link between the other parts of Ljubljana and the pedestrian zone, as most people travelling by bus prefer the bus station Konzorcij, at which 11 out of 35 bus lines are available. This furtheron attracts the pedestrian traffic.

Lastly, though to a limited extent, distance of each area to the five most visited attractions also influence the pedestrian traffic, in particular for the attractions closest to CBD-core. Therefore, the results aligned with the fourt hypothesis only partially.

6. BIBLIOGRAPHY

"Bid Rent Theory." *Wikipedia*. en.wikipedia.org/wiki/Bid_rent_theory. Accessed 14.3.2025

Booking.com. Booking.com, https://www.booking.com/index.sl.html?aid=2311236. Accessed 8.3.2025

"Center District, Ljubljana." *Wikipedia*, https://en.wikipedia.org/wiki/Center_District,_Ljubljana. Accessed 13.12.2024

"Čopova Ulica, Ljubljana." *Wikipedia*, https://sl.wikipedia.org/wiki/%C4%8Copova_ulica,_Ljubljana. Accessed 13.2.2025

"Data on Population." *United Nations Data*. https://data.un.org/Data.aspx?d=POP&f=tableCode%3A240. Accessed 13.12.2024.

Google Maps, https://www.google.com/maps. Accessed 13.12.2024

Grammarly. Grammarly, www.grammarly.com. Accessed 15.3.2025

"Ljubljana Attractions." *Lonely Planet*, https://www.lonelyplanet.com/slovenia/ljubljana/attractions. Accessed 24.1.2025

“OPM.” *OpenStreetMap* Foundation. www.openstreetmap.org. Accessed 14.3.2025

"The Region." *RRALUR*. https://rralur.si/en/region/the-region/. Accessed 1.2.2025