

**2nd international
CONFERENCE**

**the
FUTURE
DESIGN
of STREETS**

Conference Proceedings 2025

Daniel Casas-Valle

Ivo Oliveira

**University of Minho: Laboratory of Landscapes, Heritage and Territory
the Future Design of Streets association**

BOOK

the Future Design of Streets
2nd International Conference Proceedings 2025

Editors

Daniel Casas-Valle
Ivo Oliveira

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Laboratory of Landscapes
Heritage and Territory



University of Minho
School of Architecture Art and Design

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THE RICHNESS & DIVERSITY OF STREETS

This publication brings together a collection of sixteen articles, showing the richness and diversity of viewpoints that streets can have. These articles were presented at the 2nd International Conference the Future Design of Streets, on 26-27 June 2025, at the Vila Flor Cultural Centre in Guimarães, Portugal. The conference was organised by 'the Future Design of Streets association' and 'the Landscape, Heritage and Territory Laboratory of the University of Minho'.

On the first conference day, research projects (academic) and street design projects (practice) were presented in various parallel sessions organised in four key topics: Social, Nature, Mobility, and Transition. The day also included an opening session and the closing session "From Roads to Streets", which focused on urban highway transformations and was organised by the METREX group (The Network of European Metropolitan Regions and Areas). The second day was structured in a plenary format: a full day programme with several (inter)national speakers from diverse areas and backgrounds, following the four key topics. The conference counted on the following invited keynote speakers: Agustina Martire, David Sim, Demetrio Scopelliti, Éric Alonzo, Giacomo Gallo, João Rafael Santos, Juan Luis Rivas Navarro, Margarida Marques, Maria Vassilakou, Marta Garcia Chico, Michael Glotz-Richter, Nuno Lavrador and Rosário Salema. The sessions on the second day were moderated by: Sara Sucena, Ivo Oliveira, Mário Alves, and Daniel Casas-Valle.

All the sessions together provided a strong foundation for a solid debate about future challenges in street design and planning.

The articles in this publication follow the same key topics as those mentioned above. While this brings an ordering within the articles, it is also clear that streets must be also understood as complex social and cultural phenomena, which cover a whole range of topics, whether these are technical, political or social. As a complex system, streets require an articulated and broadly interdisciplinary perspective. While each article is anchored in

a specific thematic, it rapidly expands to engage with and intersect with others topics. It is precisely this diversity that the publication seeks to highlight, as it is fundamental to fostering intensified dynamics of urban transformation, and to incorporating societal and sustainable challenges.

All articles were finalised after the conference, and were subject to a peer-review process under the responsibility of the members of the Scientific Committee of the 2nd International Conference on the Future Design of Streets.

This publication is the result of a collective and generous effort, which we gratefully acknowledge and celebrate.

Daniel Casas-Valle and Ivo Oliveira

Chairs of the conference

SOCIAL

Streets are social spaces, and constitute a fundamental platform for collective life and social interaction. The articles within this thematic dimension critically examine practices of transformation and participation that seek to reassert decision-making and urban change processes increasingly shaped by community-led actions. In doing so, they question dominant top-down approaches and expose the limitations of urban transformations that marginalise local knowledge and lived experience.

These contributions draw attention to experiences and methodologies of community engagement that have become central to articulating alternatives to urban spaces subjected to gentrification and social exclusion. The articles reveal other chains of decision-making and transformation, rooted in the actions of small groups and organisations that disrupt conventional, hierarchical planning frameworks.

Originating from specific spaces, events or social groups, these practices demonstrate how the street can be reclaimed as a space of collective life, resisting reductive, functionally driven conceptions of urban space. The contributions presented here ultimately underscore the urgency of recovering everyday uses and expanding the range of programmes and activities that streets can accommodate, reaffirming their role as inclusive and contested arenas of urban life.

Feira da Cadeira: Reviving a Dormant Square through a Community-Driven market

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Figure 1. Former market in Largo do Chão das Covas (1949 to 1960). Photograph: David Freitas. © Évora Municipality Photographic Archive.

Abstract

This article presents the placemaking initiative developed by a group of undergraduate and master's students from the University of Évora, within the framework of the Erasmus+ project PLAY/ACT – Placemaking as Youth Activism. Centred on Largo do Chão das Covas in Évora's historic centre, the project sought to revitalise a once-vibrant square through a community-led intervention. Following an exploratory process rooted in participatory design, the students organised Feira da Cadeira (Chair Fair), a community market accompanied by cultural activities. While the event successfully transformed the square into a lively social and cultural hub, and was positively received by vendors, attendees, and local authorities, the project revealed important limitations from a placemaking perspective.

Despite efforts to engage local stakeholders, the project lacked long-term sustainability mechanisms, particularly due to the absence of a true place collaboration process. The community, though appreciative, did not express interest in formalising an association, which would have facilitated the follow up of the project. Challenges included time constraints, limited pre-existing relationships with the community, and the temporary nature of the intervention, which raised concerns around extractive practices. These issues risk undermining trust and leaving communities with a sense of having been used for external agendas.

Nevertheless, the project had a meaningful impact on students and local stakeholders, fostering critical reflection, civic engagement, and a sense of community pride. Although it ultimately functioned more as an educational experiment than a long-term placemaking process, the experience demonstrated the potential of small-scale, imaginative actions to spark dialogue and community bonding resulting in a hopeful, if imperfect, step toward more inclusive and caring urban futures.

Keywords

Placemaking, community market, education, citizen engagement, shortcomings

The context

In recent decades, the use of public space — particularly streets — has changed dramatically due to rising individualism, digitalisation of social life, metropolization, mass tourism, and car dominance, among other factors. Placemaking practices, understood as collaborative processes that create community-driven spaces, enhancing shared value and belonging (Perrault, 2020), have gained relevance worldwide as a response from citizens to reclaim urban spaces for themselves. Urban actions increasingly involve communities in rethinking, designing, and managing streets through grassroots action or institutional partnerships. The Project for Public Spaces lists numerous examples in its Great Streets Case Studies (www.pps.org/gps/streets).

Higher education has also integrated placemaking into applied training, such as Placemaking in the City at the University of Amsterdam and the Urban Life and Placemaking specialisation at Breda University of Applied Sciences. Inspired by these experiences, the University of Évora, with partners from Spain, Italy, and Hungary, implemented an international lifelong learning course on placemaking within the scope of the Erasmus+ project PLAY/ACT – Placemaking as Youth Activism. The course adopted a project-based learning methodology, encouraging students to apply the knowledge and skills acquired during the training to the development of a local placemaking project (Alegre, 2024a). This article examines the project led by six undergraduate and master’s students from the University of Évora enrolled in the courses Architecture, Landscape Architecture, Design, Sociology, and Visual Arts and Multimedia.

The place

The study site was chosen by the students after exploratory walks in the spirit of flâneur, and a SWOT analysis of promising locations. Largo do Chão das Covas, a square in Évora’s historic centre, was selected for its perceived potential. Although the students had no prior connection to the place, the presence of diverse organisations — including the Parish Council, a community arts centre, a kindergarten, traditional shops, and other businesses — was seen as offering potential entry points for engaging with the local community.

The first references to Largo do Chão das Covas date back to the 14th century. Its name refers to the medieval practice of storing wheat in underground pits — chão das covas meaning “ground with pits”. In the past, the square was a lively hub for social interaction, home to a variety of shops and gathering spaces such as traditional taverns. Notably, it hosted one of the city’s largest markets between 1949 and 1970. Over time, however, the square’s dynamics have changed significantly with the disappearance of these shops, taverns, and the market. Today, the square has lost much of its former significance and centrality.



Figures 2 and 3. Informal meetings with residents and friends in the square (left) and meeting with agents from culture and arts (right)

The challenge

During research, the students organised a community meeting to share memories and feelings regarding the square. Despite communication efforts — including letters to residents and posters distributed in local shops — the event saw limited attendance. Nevertheless, the following insights emerged from the consultation processes:

1. Older residents feel nostalgia for past social and commercial vibrancy of the square.
2. Younger people feel little connection to the square.
3. During the COVID-19 pandemic, a chair mysteriously appeared in the square and continues to be used by residents as a focal point for the exchange of goods.
4. Some residents envisioned the square as a stage for artistic installations and performances.

Based on these insights, the students identified the following challenges:

1. How to revive the vibrant atmosphere of the square and its former shops.
2. How to revitalise the square’s social life by transforming it into a cultural hub.

Ideation and development

After getting to know a group of neighbours who regularly meet in the square, the team joined these gatherings — often held around a table or picnic blanket with shared snacks — as a way to get input and feedback from the community at each stage of the process.

Residents and cultural actors were invited to ideation sessions where they contributed with ideas to foster collaboration and solidarity. Below, we list some of the ideas shared by the community: Cultural market with music; Garage sale; Flower market; Exchange market (goods and services) with local currency; Intercultural market; Open-air cinema; Community kitchen/oven; Repair café.

We also learned that some residents had long considered organising a car boot sale in the square but struggled with obtaining authorisation to use the public space. In response, the students proposed organising a community market with cultural activities, with the aim of temporarily reviving the square’s commercial, cultural, and social dynamics.



Figure 4. Illustration by Bruno Pinto da Cruz capturing the community's wishes and dreams for the square.

At the end of the research and ideation phases, architect Bruno Pinto da Cruz was commissioned to create an illustration capturing the community's wishes and aspirations. This artwork was presented during the community market and served as the basis for the development of activities and games.

Logistics

The market was organised in collaboration with local partners. Évora Municipality authorised the use of public space and provided logistical support, electricity, stage and furniture, reinforced the square's lighting, reopened a long-closed public toilet, and ensured cleaning throughout the day. The civil parish cleaned the area prior to the event and provided tents for the activities. A national coffee brand offered free coffee, turning an improvised esplanade into a key space for social interaction. The only paid services were the rental of audio equipment and the hiring of the DJ, the traditional singing conductor, the final concert, and the corresponding licences — totalling €3,570, which were covered by the Erasmus+ project. A call was launched for those interested in selling arts and crafts or second-hand goods, resulting in 105 applications. In the end, 76 people participated as sellers — far exceeding the 40 stalls originally planned.

A key challenge was pedestrianising the streets along the square to ensure safety, comfort, and sufficient space for both sellers and visitors. The municipality issued a temporary ban on car traffic and parking, though some residents initially ignored the restriction. The team responded by writing a letter to all neighbours and spending the evening before the event personally persuading them to leave their cars outside the square for just one day. Some were resistant and refused at first. However, to the organisers' surprise, on the morning of the event the square was almost entirely free of cars. The few remaining vehicles were



Figures 5 and 6. Photos of the square before the event (left) and in a regular day (right).



promptly removed upon request. One elderly resident looked on with nostalgia and remarked that she hadn't seen the square like that since she was a little girl.

Despite the uplifting sight of a car-free square, the team remained uncertain whether people would attend. Promotion had been carried out via the social media channels of partner organisations and in the local cultural agenda. These efforts were reinforced by distributing letters to the residents, knocking on doors to personally invite them, and handing out flyers to passers-by and in local hotels. For more information on the process, see The PLAY/ACT Placemaking Toolkit (Alegre, 2024b).

Feira da Cadeira (Chair Fair)

The Feira da Cadeira took place in Largo do Chão das Covas on Saturday, 16 March 2024. The name of the event was inspired by the chairs used by residents to exchange goods during the pandemic, symbolising neighbourly solidarity and the way people used to gather in the square.

A cultural programme was designed to engage multiple audiences, emerging from partnerships with local associations and institutions, as well as contributions from members of the community: both the DJ and the traditional singing conductor had grown up in the neighbourhood, and a well-known local musician performed in the final concert to celebrate his birthday.

Although precise attendance was unrecorded, several hundred people participated, creating a lively atmosphere and seemingly benefiting local commerce, particularly coffee shops and restaurants.

Evaluation of the event

Following the event, a questionnaire was distributed to vendors (35 responses) and fair-goers (23 responses) to assess its impact. The main findings are summarised below:



Figures 7. Photos of Feira da Cadeira. More photos at <https://flic.kr/s/aHBqjBiCLL>

1. 94% of vendors and 82% of visitors felt that the fair temporarily revived commercial dynamics of the square.
2. 91% of vendors and 95% of visitors believed it fostered social interaction.
3. The most reported feelings were “joy”, “a sense of community”, and “sharing”. All feedback was positive, except for two comments — one of which referred to a perceived lack of community involvement.
4. All vendors and 95% of visitors considered that the event should be held regularly. Vendors expressed agreement with participation fees in future editions, enabling an estimated revenue of between 500 and 800 euros.
5. Only a couple of residents reported minor disruptions in terms of traffic, parking, noise, or cleanliness, but all agreed that the positive aspects outweighed the inconveniences.

Lessons learned and future perspectives

Based on the evaluation results, we believe that the Feira da Cadeira successfully demonstrated that new uses for Largo do Chão das Covas are possible, contributing to the strengthening of community bonds. The joy expressed by residents at witnessing the square's renewed vibrancy and liveliness was unmistakable.

Nevertheless, the prospects for continuing the project are not particularly encouraging. Residents had previously attempted to organise a community market but faced obstacles, as informal groups often struggle to engage with public authorities. Although the PLAY/ACT project created opportunities for dialogue and exchange between neighbours and the municipality, these contacts, as far as we know, had little impact on the square's everyday life. The municipality recommended that residents establish a formal association to facilitate future partnerships. While formalisation can streamline management, create a sense of ownership among stakeholders, assign responsibilities, and open up opportunities for co-financing (Perrault et al., 2020), residents expressed no interest in doing so. We believe their informal character is a core strength of the group, and imposing a formal structure could undermine its authenticity. Although public bodies such as the city council and the parish council supported the event and acknowledged its value, they showed no intention

of continuing the project themselves, a step that would also contradict its community-led essence. In fact, we feel that there is a lack of participatory public mechanisms that allow informally organised groups to access public space, particularly in cases where authorisations, logistical support, and public resources are required.

From a placemaking perspective, the project revealed some shortcomings. Every place-making initiative should seek to have a lasting impact on the community, which makes long-term management a crucial consideration. Ideally, a community-led space should be self-managed by the community itself — a process described as place collaboration (Perrault et al., 2020). In this regard, Feira da Cadeira fell short, as it was mostly managed by an external organisation — the university and its group of students — and a genuine place collaboration process was never fully developed, despite the regular meetings held with residents.

The difficulty in involving local communities and motivating them to sustain the fair after the project can be attributed to different factors:

1. The time required to nurture meaningful relationships with local communities often does not align with the timeframe of financed projects and the fast-paced nature of contemporary life.
2. The temporary nature of financed projects carries the risk of extractive practices, where actions are driven more by the need to meet project objectives than by a real response to local needs. This risk must be carefully monitored and critically evaluated.
3. The project team did not have a prior close relationship with the place or its communities, which at times led team members to feel like outsiders or visitors.
4. The communities were involved in the consultation and validation processes but had limited participation in the implementation and management of the event.

The factors outlined above can generate mistrust and scepticism among local communities towards short-term projects that claim to be transformative but fail to deliver sustained commitment or long-term impact. This may leave residents with the impression of having been used or instrumentalised. This is the reason why Francesco Careri argues that the notion of participation should be reframed as taking care: “A methodology for stopping, and for taking part in a process, starts with the quest for a place where we may be sure that things will endure after our departure, and stopping precisely where the ground is fertile. If one walks with seeds, one must plant with the Other, precisely where he will be able to water them. The Elsewhere is only accessible where the Other will take care of the works installed with him” (Careri, 2016, p. 11). This, ultimately, was where we failed. The issue is not that the Feira da Cadeira did not continue, since intermittent practices are important “forms of activities, expressions, and relationships that enable and empower temporariness and sharing in the city” (Ochoa, 2022, p. 197), but rather that the process did not prove to have significantly fostered collaborative engagement among residents. On the other hand, national and international examples — such as Rua da Cidade de Manchester, in Lisbon,

inspired by the Italian project Social Street (www.socialstreet.it) — show how the mobilisation of residents around a circumstantial concern (in this case, the cutting down of trees planned by the Lisbon municipality) can evolve into lasting processes of place collaboration. However, there are two crucial differences from our case study: in the case of Rua da Cidade de Manchester, the initiatives were led by residents themselves, rather than initiated from outside; and the residents formally organised themselves into an association.

A small-scale utopia

The impact of the project on its stakeholders was assessed through questionnaires and semi-structured interviews conducted with students, staff, gatekeepers, and community members. Despite the reflections above, the findings indicate that the project contributed to fostering future collaborations and strengthening relationships with local stakeholders and communities. The vice-president of the municipality and a resident highlighted the project's relevance, praising its ability to mobilise local people and reinvigorate the neighbourhood's identity, although sustaining such initiatives over time depends on the ongoing commitment and active involvement of residents. Overall, students found the project to be an enriching experience that enhanced their cooperation skills, reinforced academic learning, and deepened their civic engagement. The contact between the project team and the residents did not end after the project finished, and we are often invited to participate in initiatives organised by them, as was recently the case with a series of guided tours of the neighbourhood's trees. This shows that interpersonal relationships survive the temporality of the events, leaving new opportunities for collaboration open.

In conclusion, we consider the experience to have been both positive and meaningful for all parties involved. We see it as an opportunity to build a small-scale utopia—or, in the words of Kevin Kelly, an optimistic and achievable protopia (Nedelman, 2023). For now, the revitalisation of Largo do Chão das Covas remains a dream, still waiting to come true through sustained collaboration. With that in mind, new projects are already on the horizon.

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Social Street Design: Activating Urban Communities through Multi-Layered Engagement in Cologne’s Steubenstraße

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Abstract

Post-industrial European neighbourhoods face complex challenges of social fragmentation, environmental degradation, and limited civic participation, particularly in culturally diverse areas. This practice-based case study examines how professionally facilitated social design interventions can achieve genuine community empowerment while addressing environmental justice concerns. Through systematic analysis of the Steubenstraße intervention in Cologne-Bickendorf, implemented by icon – a social design agency with 10 years of neighbourhood activation experience – we investigate the research question: How can participatory social design approaches achieve sustainable neighbourhood activation in culturally diverse urban quarters, and what factors determine genuine participatory decision-making versus consultation-based approaches? The intervention, carried out as part of Cologne’s “Hallo Nachbar, Danke schön” initiative, demonstrates measurable community and environmental outcomes while revealing critical limitations in participation depth and long-term sustainability.

Keywords

Community activation, social design, urban transformation, neighbourhood engagement, sustainable development, participatory planning, environmental justice

1. Introduction and Research Problem

1.1 Problem Statement and Local Context - Steubenstraße in Cologne-Bickendorf exemplifies the challenges facing post-industrial European neighbourhoods: 60% of residents have migration backgrounds (primarily Turkish-speaking), creating language barriers that exclude many from municipal communication and civic processes. The street suffers from illegal waste dumping, limited green infrastructure, and weak social cohesion—issues heightened by cultural diversity that remains unused as a community resource.

This case represents wider urban challenges where environmental problems intersect with social exclusion. The selection of Steubenstraße was strategic. Its inclusion in Cologne's "Sozialraumgebiete – Lebenswerte Veedel in Köln" program and its representative demographic profile make it a suitable site for testing transferable approaches to participatory environmental management in diverse urban contexts.

1.2 Research Objectives - Primary Objective: To analyze how multi-layered social design interventions can achieve sustainable community activation while promoting environmental care in culturally diverse neighbourhoods.

Secondary Objectives: Evaluate the depth of genuine participation versus consultation in community decision-making processes; Assess the effectiveness of multilingual, culturally sensitive engagement strategies (German-Turkish); Identify transferable elements and adaptation requirements for similar urban contexts; Critically examine limitations, risks, and sustainability challenges.

1.3 Theoretical Framework - This study builds on four theoretical foundations relevant to German urban planning contexts:

Participatory Urban Planning: Following Selle's (2013) framework on "Beyond Citizen Participation: Urban Development as a Community Task?", we examine how genuine community involvement can transform from consultation to co-creation. Selle's work provides practical guidance for moving beyond tokenistic participation toward meaningful community empowerment in German planning contexts.

Neighbourhood Management (Quartiersmanagement): Building on Alisch's (2002) "Social Urban Development" and Kessl & Reutlinger's (2010) "Social Space" frameworks, we apply established German approaches to neighbourhood activation that directly connect to Germany's Quartiersmanagement programs and Cologne's "Sozialraumgebiete – Lebenswerte Veedel in Köln" initiative.

Tactical Urbanism: Drawing from Lydon & Garcia's (2015) analysis of short-term action for long-term change, we analyze how small-scale, temporary interventions can catalyze broader urban transformation, particularly relevant for German cities implementing pilot projects before permanent implementation.

Environmental Justice (German Context): Incorporating Böhme et al.'s (2015) research on "Environmental Justice in Urban Space" from the German Institute for Urban Affairs, we examine how participatory environmental management can address social disparities in German cities, complemented by Bauriedl's (2007) work on environmental discourse power dynamics.

2. Methodology and Intervention Design

2.1 Case Study Context and Practitioner Approach

This practice-based case study documents a real-world intervention implemented by icon, a social design agency specializing in neighbourhood activation with 10 years of experience in participatory community engagement. The intervention operated over 15 months (2023-2024) with a budget of approximately €45,000, structured in four phases:

Phase 1: Community Mapping and Trust Building (Months 1-3)

- Systematic door-to-door visits reaching 60 households (~40% of street residents), with facilitated access through GAG Immobilien AG, Cologne's largest housing provider
- Establishment of bilingual contact persons (German-Turkish)
- Initial community mapping sessions identifying "good and bad places"
- Introduction of the mobile information bike "Hallo Nachbar-Infobike"

Phase 2: Participatory Planning and Priority Setting (Months 4-6)

- Mind mapping sessions for shared vision development (8 sessions, 45 participants)
- Community identification of intervention priorities through resident-led discussions
- Stakeholder alignment meetings with municipal departments
- Resource allocation planning based on community input

Phase 3: Implementation and Community Activation (Months 7-12)

- Community-led green-space adoption around existing street trees
- Regular street activities and workshops (resident-requested formats)
- Waste awareness campaign implementation
- Cultural integration programming (community-designed)
- Infrastructure improvements through municipal coordination

Phase 4: Evaluation and Sustainability Planning (Months 13-15)

- Impact assessment and community feedback collection
- Ongoing biologist-led workshops on building and installing birdhouses in the neighbourhood
- Volunteer structure establishment for long-term sustainability
- Documentation and transferability analysis

2.2 Participation Analysis: Decision-Making vs. Consultation - Genuine Resident Decision-Making: Residents exercised authentic decision-making authority in selecting specific native plant species and determining optimal planting locations for gardening plots

around existing street trees. The community took full ownership of designing and curating content for the neighbourhood festival “Steubenstraße in Bewegung”, ensuring it reflected their cultural values and interests. Turkish-speaking women in the community had complete autonomy in scheduling and formatting bike-riding courses to accommodate their specific needs, cultural considerations, and availability. Residents also maintained control over determining the content and timing of various neighbourhood activities, allowing them to shape programming according to their preferences and community rhythms.

Professional/Municipal Decision-Making (with resident consultation): The overall project framework and budget allocation remained under professional and municipal control, with residents providing input through consultation processes rather than direct decision-making authority. Municipal stakeholders retained responsibility for selecting environmental focus areas such as waste management and urban greening strategies, though they incorporated resident feedback into these choices. Stakeholder coordination protocols were established and managed by professional facilitators, ensuring systematic communication between various municipal departments and community representatives. Documentation and evaluation methods were designed and implemented by professional staff to meet academic and municipal reporting requirements, though residents contributed data and feedback to these processes.

Critical Assessment: This analysis reveals that while residents had significant input on implementation details and activity design, fundamental project direction remained with professional and municipal stakeholders—a limitation requiring acknowledgment. The intervention achieved meaningful community engagement within existing power structures rather than fundamentally redistributing decision-making authority, representing consultation and collaboration rather than citizen control according to Arnstein’s “ladder of participation”.

2.3 Stakeholder Coordination Model - Icon functions as central coordination hub between:

- Municipal departments (Environmental Office, Integration Office, District Administration, Public Order Office)
- Waste management company AWB GmbH
- GAG Immobilien AG as key cooperation partner, facilitating household access and supporting project recommendations
- Local community organizations
- Educational institutions (schools, adult education centers)

The partnership with GAG Immobilien AG proved essential for project success, as the housing association not only facilitated access to residents but also endorsed and supported the project’s environmental and social recommendations, lending institutional credibility to community engagement efforts.

The collaboration with the Public Order Office (Ordnungsamt) addresses critical neighbour-

hood issues including illegal parking in turning areas and abandoned bicycles chained to tree bed areas, ensuring that environmental improvements are not undermined by regulatory violations.

3. Results and Critical Assessment

3.1 Quantitative Outcomes

Community Engagement:

- Street festival participation: 200 residents
- Household visits completed: 60 (40% of street residents)
- Weekly Infobike conversations: average of 20 individual conversations
- Workshop participation: 150+ residents across all activities

Environmental Impact:

- Green-space adoption around existing trees: 4 (with native, near-natural plantings)
- New bicycle parking spaces installed: 3 (by City of Cologne)
- Public waste bin installation: 1 (by AWB)
- New paper recycling containers: multiple (free service in Cologne, reducing residual waste)
- Native plant species introduction: 8 locations around existing street trees
- Visible waste reduction: 30% decrease in illegal dumping

Infrastructure Improvements: The intervention successfully coordinated with municipal services to address resident-identified needs: bicycle parking spaces enhance sustainable mobility options, additional waste bins reduce illegal dumping, and paper recycling containers (free in Cologne) provide residents with waste reduction opportunities while decreasing residual waste volumes. Collaboration with the Public Order Office addresses illegal parking in turning areas and removal of abandoned bicycles from tree bed areas, protecting newly established green-space adoptions.

3.2 Qualitative Impact Assessment - Community Cohesion Indicators:

- Increased intercultural interaction reported by 70% of surveyed residents
- Formation of informal neighbourhood networks beyond project activities
- Multilingual communication normalization in daily interactions
- Resident-initiated activities beyond formal programming

Environmental Awareness:

- Community ownership of green spaces through green-space adoption programs around existing trees
- Self-organized maintenance of adopted planting areas by the community
- Improved waste separation practices (25% increase in proper sorting)
- Ongoing environmental education through biologist-led birdhouse workshops

3.3 Critical Limitations and Risks - Participation Depth Constraints:

While the project achieved significant community engagement, genuine decision-making power remained primarily with municipal and professional stakeholders. Resident input influenced implementation details rather than fundamental project direction, representing consultation rather than citizen control on Arnstein's ladder.

Representation Challenges: Despite multilingual approaches, certain community segments remained underrepresented, particularly elderly residents and families with very young children. The 40% household reach, while substantial, means 60% of residents had limited direct engagement.

Sustainability Uncertainties: Long-term impact depends on continued municipal support and community volunteer capacity, both subject to external pressures. Without ongoing professional facilitation, community networks may weaken over time.

Gentrification Risks: Neighbourhood improvements may contribute to property value increases, potentially displacing lower-income residents – a concern requiring ongoing monitoring and mitigation strategies.

Resource Intensity: The intervention required substantial initial investment (€45,000 for one street) and intensive professional facilitation, raising questions about scalability and cost-effectiveness for broader municipal application.

4. Transferability and Future Applications

4.1 Transferable Elements - Scalable Components:

- Bilingual contact person model (German-Turkish, adaptable to different cultural contexts)
- Infobike model: Mobile information and engagement concept
- Integrated environmental-social programming approach
- Stakeholder coordination framework between municipal departments
- Housing association partnership model for resident access and institutional support
- Green-space adoption model around existing urban trees with native plantings
- Public Order Office coordination for regulatory enforcement

Adaptation Requirements:

- Cultural sensitivity protocols specific to local demographics
- Municipal partnership structures aligned with local governance systems
- Environmental priorities matching local ecological needs and existing infrastructure
- Resource allocation models fitting available funding structures

4.2 Critical Success Factors - Essential Elements:

Sustained professional facilitation by an experienced social design agency forms the foundation for successful neighbourhood activation. A strong partnership with the housing association (GAG) is crucial for enabling resident access and obtaining institutional support for project recommendations.

Genuine multilingual communication (German-Turkish) goes far beyond simple translation and creates culturally sensitive connections to the community. The integration of environmental and social objectives ensures a holistic approach to sustainable neighbourhood development.

Multi-departmental municipal coordination, including the Public Order Office for regulatory enforcement, is essential for comprehensive project implementation. Strong multi-stakeholder partnerships with clear coordination protocols create the necessary structure for effective collaboration.

Finally, coordination with municipal services enables concrete infrastructure improvements that directly address resident-identified needs.

These success factors demonstrate that Social Street Design is a systematic approach that combines professional expertise, institutional partnerships, and genuine citizen participation.

Context-Specific Adaptations for Social Design Interventions:

Cultural mediation approaches must be carefully tailored to address the specific dynamics of Turkish-German community interactions, recognizing the unique cultural bridges and potential barriers that exist within this demographic context. Environmental focus areas should be strategically aligned with local challenges and existing infrastructure, ensuring that sustainability initiatives build upon available resources rather than requiring entirely new systems.

Participation formats need to be thoughtfully adapted to accommodate community preferences and constraints, including cultural practices, work schedules, and family obligations that may influence resident engagement patterns. Housing association engagement strategies must be customized to fit local ownership structures, recognizing that different neighbourhoods may have varying relationships between residents, property management, and municipal authorities.

These context-specific adaptations ensure that social design interventions are not merely transplanted from other locations but are genuinely rooted in the particular social, cultural, and institutional landscape of each neighbourhood. The success of such interventions depends on this deep understanding of local conditions and the flexibility to modify approaches accordingly.



Figure 1. (from left to right) Map with good and bad places in the neighbourhood, marked by neighbours www.hallonachbar.koeln/dreimalschoener/; Poster 'Your Steubenstraße on the move'; Poster 'Some-thing is blooming! – Become a green-space adopter'

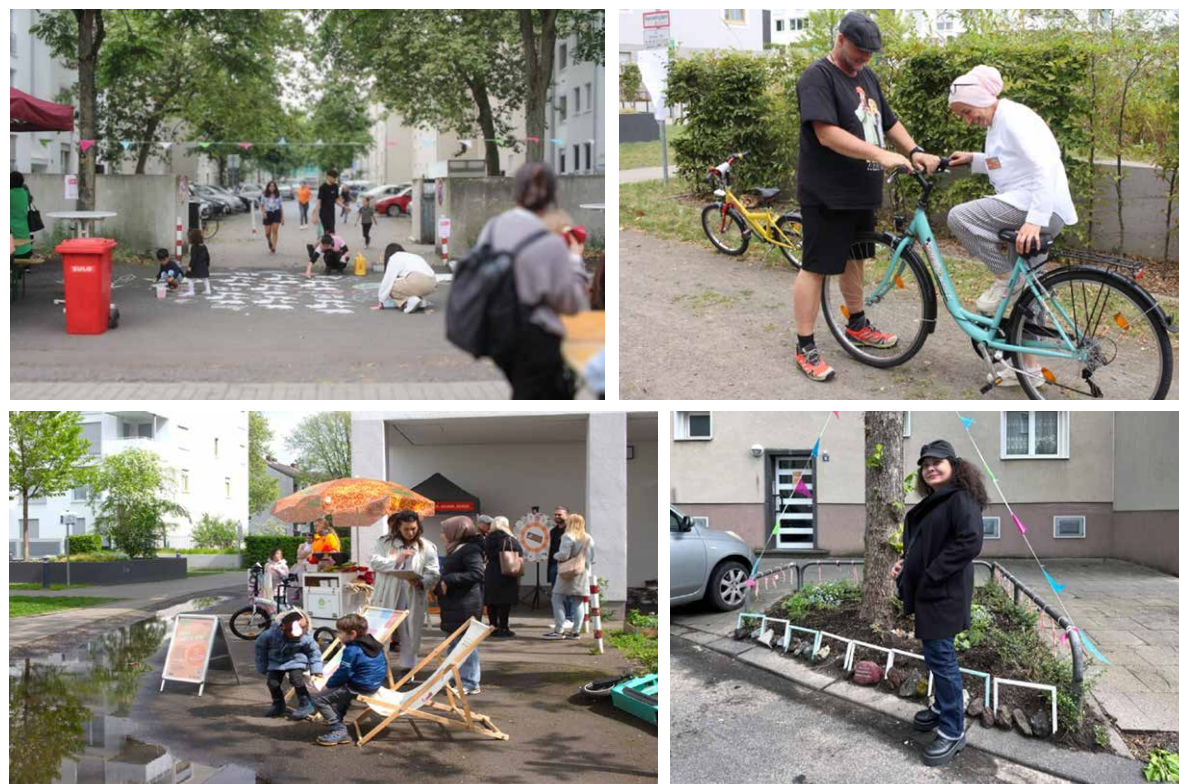


Figure 2. (from left to right) Poster 'Save yourself from waste!'; Street rubbish collected in front of the neighbourhood storefront 'Halle im Coloria!'

This adaptive framework demonstrates that effective social street design requires both systematic methodology and contextual sensitivity to achieve meaningful and sustainable community transformation.

5. Conclusion and Knowledge Contribution

The Steubenstraße intervention demonstrates that professionally facilitated social design approaches implemented by experienced practitioners can effectively activate urban communities and achieve measurable environmental improvements in culturally diverse neighbourhoods. However, critical reflection reveals important limitations: genuine community participation in fundamental decision-making remained constrained, certain population segments were underrepresented, and long-term sustainability depends on continued external support.

Key Contribution to Knowledge - This practice-based case study provides evidence that multi-layered social design interventions can achieve measurable community and environmental outcomes in diverse urban contexts, while highlighting the need for honest assessment of participation quality, representation equity, and sustainability planning. The intervention achieved significant community activation within existing power structures rather than fundamentally redistributing decision-making authority. The critical role of housing association partnerships in facilitating community access and lending institutional credibility represents a key finding for similar interventions, as does the importance of coordinating with municipal services for infrastructure improvements that address resident-identified needs and regulatory enforcement through Public Order Office collaboration.

Implications for Practice - Future applications should address participation depth, representation equity, and sustainability planning from project inception. The model offers valuable insights for similar urban contexts, particularly regarding the integration of envi-

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ronmental management with community engagement, the strategic importance of housing asso-ciation partnerships, and the effectiveness of working within existing urban infrastruc-ture (green-space adop-tions around existing trees rather than new plantings). The case demonstrates the ongoing tension between professional facilitation and genuine community empowerment while showcasing the practical achievements possible through experienced social design agency implementation and comprehensive municipal coordination.

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From Street to Tourist Attraction

The Transformation of Rua Nova de São Lázaro in Macau

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Abstract

This article is part of ongoing doctoral research into the Portuguese influence on urban planning and architecture in Macau during the sovereignty transition period (1974–1999). It is structured in three parts: the first explores the neighborhood and its historical context, while the second and third focus on *Rua Nova de São Lázaro* and the successive transformations it has undergone. The adopted structure — Part I: *The Neighborhood*; Part II: *The Street*; Part III: *The Tourist Attraction* — symbolically reflects the path taken by this street over time in the context of increasing globalization.

Processes of gentrification and the transformation of Macau into areas of imminent tourist activity have led to the conversion of historically community-based areas into reserved and, to some extent, exclusive urban spaces. Public space has thus progressively lost its original function, giving way to an environment shaped by visual and economic consumption.

Rua de São Lázaro is a notable example, as its history is deeply intertwined with the territory's urban and cultural development. Originally, the area was known for sheltering people with leprosy, which explains its association with Saint Lazarus, the patron saint of lepers. In the early 19th century, the neighborhood expanded in a disorderly manner, prompting the need for restructuring. In response, an urban reorganization plan was implemented in 1903 to improve hygiene and habitability, including the creation of new roads — namely *Rua Nova de São Lázaro* and *Calçada de São Lázaro*.

In 1999, following the transfer of sovereignty to China, these streets underwent a rehabilitation process marked by the introduction of Portuguese-style cobblestones and European streetlamps. The incorporation of these decorative elements, which evoke the colonial past, raises questions about the transformations imposed on this street, largely driven by growing tourist pressure.

The study of this street goes beyond a technical analysis, inviting reflection on the broader implications of transitions in urban space, particularly in Macau. As architects, we have a responsibility to address gentrification, both in Portugal and abroad — especially when it involves the preservation of tangible and intangible elements of Portuguese cultural heritage.

Keywords

Heritage, portuguese architecture, Macau, street transformation

Introduction

This article forms part of the initial stage of a doctoral investigation whose objective is to analyze the presence of Portuguese culture and identity in Macau through the study of architectural and urban objects designed by Portuguese architects. The central aim is to determine whether contemporary Macau can be understood within the framework of a new urban “-topia,” conceived as a theoretical tool for interpreting architectural space. Since the methodological approach is directly linked to the research objectives, the study adopts an inductive scientific method. For the fieldwork, an empirical approach is employed, which is essential for data collection. This method is based on direct observation and practical experience, complemented by documentary research, literature review, and research trips, during which interviews, surveys, and archival analyses will be conducted in local institutions.

From an architectural perspective, Macau reveals a profound connection to Portuguese heritage, still visible today in its streets, squares, and historic buildings. Within this context, the present article is situated within a broader trajectory but adopts an experimental approach: rather than explaining a consolidated situation, it seeks to explore an emerging reality—namely, a street characterized by elements of Portuguese and European inspiration.

Rua Nova de São Lázaro is in the eastern part of the São Lázaro neighbourhood, at the foot of Guia Hill, in what is also known as the Parish of São Lázaro. Situated in the center of the Macau Peninsula, this parish covers an area of 0.60 km² and has a population of approximately 26,900 inhabitants. Although it is the smallest parish in the Macau Special Administrative Region, it stands out for its atmosphere that evokes Macau’s colonial heritage and for its strong artistic character, evidenced by the presence of museums, art galleries, and cultural centers. According to José Morais, in the article “*The Village Feeling in the Neighbourhood of S. Lázaro*” (2014), this neighbourhood preserves a village-like spirit, conveyed by its tranquillity and the conservation of its built heritage. Thus, the neighbourhood’s identity reflects the successive transformations of its urban landscape since its formation.

Part I - The Neighborhood

The Portuguese settled in Macau in 1557. In 1568, the Portuguese Jesuit Belchior Carneiro arrived in the territory (Instituto Para os Assuntos Municipais, n.d). According to Kevin Carreira Soares, in his study “*The Bishops of Macau (1576–1782)*” (2015), Carneiro was the first bishop to exercise effective authority in Macau, playing a decisive role in the formation of the city and the consolidation of episcopal power in the region. Upon his arrival, the São Lázaro neighborhood caught his attention due to its extreme poverty and its function as a shelter for lepers, many of whom had been abandoned. (Soares, 2015)

There are two different versions regarding the construction of the Church of *Nossa Senhora da Esperança*. Although neither can be confirmed, this study adopts the interpretation

proposed by João Botas. According to his study, in the year following his arrival, Belchior Carneiro founded the *Hospital de São Rafael*, with an annex specifically designed to accommodate lepers, near a small pre-existing chapel. This hermitage would later give rise to the Church completed in 1570 to provide spiritual support to the sick. This site corresponds today to the current Church of São Lázaro (1885/18886), named in honor of the patron saint of lepers. (Botas, 2014)

“Little by little, the city took shape. Churches ceased to be simple wooden structures and became the most important buildings of Macau’s scholarly heritage (...). The fortifications, which the Chinese opposed during the first hundred years, later became permanent and solid constructions, defending the city from foreign attacks from the sea, in a rational and planned system.” (Figueira, 1988)

Manuel Basílio, in his article “*The São Lázaro Neighbourhood of Macau and its Historical Background*” (2018), notes that, in addition to religious concerns, there was also a dilemma related to the defense of Macau. After the Portuguese established themselves in the territory, the Chinese authorities initially refused to grant permission for the construction of fortifications, fearing that these could be turned against China itself. However, following successive Dutch attempts to invade the territory, the Chinese authorities ultimately authorized the construction of defensive structures. The building of the defensive wall proved particularly significant for the development of the São Lázaro neighbourhood, as the expansion of fortifications led to population growth beyond the walled limits. It was in this context that the residential area that would later become the present-day São Lázaro neighbourhood began to take shape. (Basílio, 2018)

“These sparse and open Portuguese enclaves were connected to the Chinese areas, which were completely different in character, densely populated, with narrow streets of gray brick houses, almost always similar. The two populations did not mix (...), the Portuguese had their neighborhoods, and the Chinese had theirs.” (Figueira, 1988)

The São Lázaro neighborhood, characterized by precarious constructions, was inhabited primarily by Chinese Christians, who lived in a disorganized urban fabric composed of narrow alleys, crooked crossings, misaligned buildings, and poor sanitary conditions, including open sewers (*Revista Macau*, 2014). This urban, social, and sanitary context frequently contributed to the outbreak of endemic diseases, posing a constant threat to public health. The situation deteriorated further during the 1894 bubonic plague epidemic, which severely affected the neighborhood. In response, Governor Eduardo Galhardo ordered the demolition of the area to begin an urban redevelopment plan. (Basílio, 2018)

In 1903, São Lázaro became the first neighborhood in Macau to undergo planned urban development, carried out according to a project designed by the Spanish architect J. M. Casuso. The new plan proposed an orthogonal organization of streets and blocks, as well as the construction of new two-story houses characterized by eclectic architectural influences. (Tostões, n.d)



Figure 1. (left) Tai Fung Tong Art House (1927). Two-storey houses.

Figure 2. (right) Tai Fung Tong Art House (2017). Houses with more than two floors..

“Nothing is subtle or suggested: the underlining, in various colors, of the urban text emphasizes common words—door, window, balcony, cornice—referring to styles that arrive from afar, at different times and by different means (...) Mannerism, Baroque, Neoclassical, Art Nouveau, Art Deco, Modern Style, Rationalism, Populism-Organicism, Brutalism, Post-Modernism.” (Vicente, 1986)

With the urban transformation of the São Lázaro neighborhood, its demographic composition also changed, becoming predominantly inhabited by Macanese families (of Portuguese descent). This configuration remained largely stable for several decades, until between 1970 and 1980, when many of these families began to move to other areas of the Macau Peninsula (Tostões, n.d). According to Basílio, this demographic shift had significant consequences: many of the houses formerly occupied by Macanese families were sold and subsequently demolished, making way for the construction of five- to six-story residential and commercial buildings, which were then inhabited by Chinese residents.

This paradigm shift—marked by the verticalization of the neighborhood—resulted in the loss of much of its original identity. In response to this phenomenon, the local government-initiated conservation efforts aimed at protecting and enhancing the neighborhood’s architectural heritage.

Part II - From the Street

This article focuses specifically on *Rua Nova de São Lázaro* (formerly *Rua de São Lázaro*), as this street is emblematic of the broader transformations that have shaped the neighborhood. Although it is not the parish’s main thoroughfare, it possesses an urban complexity that reveals multiple layers of meaning relevant to this research.

After the transfer of sovereignty from Portugal to the People’s Republic of China, a policy of recognizing and valuing the Portuguese legacy in Macau was implemented, as part of an effort to strengthen ties “between the Portuguese-speaking world and the greatest emerging power of the 21st century” (Rangel, 2017). A major milestone in this process was the

inscription of the Historic Centre of Macau on the UNESCO World Heritage List in July 2005.

Although *Rua Nova de São Lázaro* does not fall directly within the boundaries of the classified World Heritage area, it is situated on the edge of the surrounding buffer zone. In this regard, it may be argued that the renovation of the neighborhood was part of a strategic effort to extend the heritage value attributed to this section of the peninsula. However, it may also be suggested that the interventions were primarily motivated by an intention to recover the historical ambiance traditionally associated with the São Lázaro neighborhood.

Rua Nova de São Lázaro underwent an intervention aimed at integrating it into the cultural and artistic dynamics of the city, promoting it as an artistic and creative hub. To this end, European-style streetlamps and Portuguese cobblestones were installed, evoking an atmosphere of colonial memory (Gabinete de Comunicação Social, 2014). Although *Rua Nova de São Lázaro* is one of several thoroughfares in this neighborhood, it stands out due to a specific and significant feature: it lies directly in front of the main entrance to the Church of São Lázaro, thus playing a crucial role in guiding both residents and visitors to this religious landmark. The street begins at the intersection of *Rua do Pato* and *Calçada do Poço*. Notably, only the latter half of its length is paved with Portuguese cobblestones—a detail that constitutes the focus of this analysis.

As this article is part of doctoral research initiated in February 2025, the first fieldwork trip to Macau has not yet been conducted. Given this limitation, the analysis is based on images available through Google Maps, photographed in different years. For comparative study and urban evolution analysis, images from 2008 and 2019 will be examined, enabling a chronological assessment of the changes that occurred on the street over an eleven-year period.

Figure 3. Moodboard on Rua Nova de São Lázaro.



journal “*Indústria e Ambiente*”, as part of the 2022 edition of the conference “*The Future Design of Streets*”, will be referenced:

“The concept of a street encompasses a multitude of models, so it is necessary to consider the analysis of **mobility**—both pedestrian and cyclist mobility, as well as the space that cars have come to occupy. The street also serves as **a social space**, a place for socializing and leisure, **a cultural space** that hosts a wide variety of celebrations, and **an economic space** for the provision of services and economic transactions. All this without forgetting the aspects of sustainability and climate adaptation.” (Vilaça, 2022)

Mobility on *Rua Nova de São Lázaro* is ensured by cars, motorcycles, and pedestrians, although there is no infrastructure for bicycles. A comparative analysis of images from 2008 and 2019 reveals a shift in the traffic paradigm: while car traffic was previously permitted, access has since been restricted to motorcycles, which are allowed to circulate and park along the street. Pedestrian circulation is possible on both sides, where the traditional curbs have been replaced by vertical separation elements.

The street’s potential as a **space for social interaction** and leisure is limited by its narrow width and the coexistence of vehicular traffic, which restricts opportunities for community engagement. Although the presence of residential buildings could, in theory, promote neighborly interaction, it is the churchyard of the Church of São Lázaro—located at the end of the street—those functions as an extension of public space. Thus, *Rua Nova de São Lázaro* serves primarily as a passageway and parking area, culminating in an “oasis” defined by the churchyard.

In **cultural terms**, the street is enlivened by the presence of the *Tai Fung Tong Art House Chui Lok Chi Mansions* building, visible to the right in Figure 2 and 3. Well-preserved and situated opposite the church, this building contributes to the street’s cultural vitality and draws visitors to the area. Its significance lies in the fact that one of the key objectives of the neighborhood’s renovation was to establish cultural institutions, aiming to transform the area into a cultural hub in Macau.

Economically, the street is supported by small commercial establishments located on the ground floors of residential buildings. These businesses play a vital role in attracting foot traffic and reinforcing the street’s function as a connector and access point to the church.

Part III - To Tourist Attraction

Gentrification is one of the most significant phenomena of urban transformation in major cities. The concept was introduced by sociologist Ruth Glass (1912–1990) in her book *London: Aspects of Change* (1964), in which she analyzed the transformations taking place in various working-class neighborhoods of London. In its initial formulation, gentrification referred to the transformation of urban landscapes and the changes in the uses and meanings attributed to old and/or working-class areas, often marked by signs of physical degradation (Alcântara, 2018).

Sixty-one years after Glass’s publication, the concept remains highly relevant and analyti-



Figure 4. (left) Street in the São Lázaro neighborhood. (Photo taken from the HPIP website)



Figure 5. Churchyard and Church of São Lázaro. (Photo taken from Google Maps)



Figure 6. (right) Street in front of the Church of São Lázaro. (Photo taken from the Crônicas Macaenses website)

cally valuable, describing the social and urban changes observed in central areas, often driven by public and private investments aimed at rehabilitating deteriorated buildings. In general terms, gentrification involves the arrival of new, middle- to upper-income residents in previously devalued areas, triggering changes in the urban fabric and contributing to the economic and social reconfiguration of these territories.

The most recent transformation in the configuration of *Rua Nova de São Lázaro* and its surroundings took place around 1999, coinciding with the transfer of sovereignty over Macau. Although the designation of the *Historic Centre of Macau* as a UNESCO World Heritage Site only occurred in 2005, the author of this article—despite not having found documentary evidence to support this assumption—proposes that the neighborhood was intentionally developed as a cultural hub. The introduction of Portuguese cobblestones and European-style streetlamps appears to have aimed at reinforcing the cultural identity of the area and deepening symbolic ties with the Portuguese legacy. This reading also helps explain the presence of art galleries and museums in the vicinity. In this sense, it is understood that there was a strategic effort to place this neighborhood on Macau’s tourist and cultural map.

The term *touristification* refers to the process by which tourism becomes a driving force in the transformation of a territory—particularly from the second half of the 20th century onward. This dynamic manifests in the physical, social, and economic restructuring of cities through the proliferation of infrastructure and services tailored to visitors, to enhance the city’s attractiveness as a tourist destination. Although it is difficult to pinpoint the exact moment when the term emerged, it began to gain prominence in academic literature during the 1980s. Among the more recent publications that address the concept are works by Ojeda and Kieffer (2020) and Kowalczyk-Anioł (2020), as noted by Hernández and Calle-Vaquero (2023).

The function of buildings on *Rua Nova de São Lázaro* has adapted to the growing influence of tourism and the increasing demand for a more internationalized city image. Although this street is not included in every tourist itinerary of Macau, it is considered crucial for understanding the transformation of the territory. The touristification of *Rua Nova de São*

Lázaro illustrates the shift from local community space to a cultural showcase aligned with Macau’s global image.

“In Macau, everything has been transformed (...) The city is a territory where cement calligraphy overlaps. We must walk through its streets and buildings until we reach the Portuguese temple: the square, the medieval grid, the neoclassical building, the art deco, modernism. (...) Portuguese architecture, however, has historically played a mediating role in the construction of the territory, without merely replicating original models uncritically.” (Figueira, 2006)

The analysis of *Rua Nova de São Lázaro*, as a microcosm of Macau’s broader urban dynamics, allows for the exploration of the multiple historical, social, and architectural layers that define the São Lázaro neighborhood. Once marked by precariousness, this territory has gradually been transformed into an urban area where built heritage, colonial memory, and Portuguese cultural presence coexist with the contemporary challenges of urban development. This reflection aims to contribute to the debate on the responsibility of intervening in cities with historical, social, and cultural awareness, advocating for the preservation of urban identity in the face of market pressures and tourist homogenization.

Although this research is in the beginning, several concrete conclusions can be highlighted. There is a growing recognition of the importance of designing streets as multifunctional spaces that go beyond mere vehicular flow, incorporating active mobility, social interaction areas, and green spaces. This approach reinforces the centrality of the human user in urban design, fostering greater social interaction and quality of life.

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RegenerAction(s): How Urban Community Builders can change our cities?

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Abstract

Motivated by the need to reuse disused public spaces in cities, many people are interested in urban regeneration processes as tools for engagement with the community. That is why the figure of the urban community builder has appeared.

In the scope of a two-years ERASMUS + project named REGENERATION, we aimed at establishing a common vision of what an urban community builder is and does, the challenges he/she faces and how they can be overcome. In that sense, this project defined Urban Community Builders as, therefore, professional profiles capable of assisting the community in co-designing, constructing, and bringing the new public space to life. The project was made up of different European partners: _ARTERIA_LAB (UÉvora, PT), Institut de Recherche et Innovation du Centre Pompidou (Paris, FR), InnoHub (Valencia, ES), Materahub (Matera, IT) and Urbani Separe (Rijeka, CR) that implemented, all together, this project in each territory.

These regeneration actions are projects capable of giving new life to these common assets through participatory processes. This implies that, in order to exist, these regeneration actions require a community of people revolving around that asset and obtaining social, economic, and cultural value from that space. In order to achieve these goals, we identified Urban Community Builders as agents of change, creating relationships, cooperating, through a holistic and multidisciplinary approach, embracing the new challenges of participation as an opportunity.

In this article, we pretend to present the process of research, engagement with the local agents in each country, but also to share the different documents and actions developed in each city, mainly our Manifesto and Policy Recommendation Paper, trying to figure out, together, what can be the relevance of these profiles in the design process of our cities.

Keywords

RegenerAction, urban community builders, participatory urban planning, public policies

Introduction

RegenerAction was conceived as a response to the growing need for more inclusive, accessible and community-driven approaches to urban transformation. It called for greater and more persistent involvement of civil society—particularly local communities—in the imagining, meaning-making and co-design of public and common spaces. The project offered an opportunity to articulate a vision for more welcoming, diverse, multicultural and sustainable cities, rooted in participatory urban planning and collective agency.

The project was developed by a consortium of five European entities: IRI – Institut de Recherche et Innovation du Centre Pompidou (lead partner, Paris, France), Materahub (Matera, Italy), Urbani Separe (Rijeka, Croatia), _ARTERIA_LAB – Universidade de Évora (Évora, Portugal), and InnoHub (Valencia, Spain). Framed within a two-year ERASMUS+ programme (2022–2024), RegenerAction aimed to disseminate a new understanding of urban regeneration where processes begin with the collective action of local communities and to define the emerging profile of the Urban Community Builder (UCB) as a relevant actor in European urban policy and practice.

One of the main goals of the project was to train and empower groups of local actors to actively contribute to urban regeneration by developing their capacities to engage, co-design, and co-steward public spaces. The figure of the Urban Community Builder was introduced as a hybrid profile capable of operating across formal and informal roles, mediating between top-down structures and bottom-up community initiatives. These individuals or collectives are seen as agents of physical, social and cultural change, facilitators of regenerative actions (regenerations) that value relationships, diversity, and shared responsibility.

Regenerations refer to holistic, participatory processes that redefine urban life and space—whether urban, peri-urban, or rural—through the revitalisation of underused buildings, neglected public infrastructure and common green areas. These actions are only possible when rooted in broad civic engagement, trust-building and sustained collaboration between communities and institutions. As such, regenerations are framed as co-created processes that generate social, ecological, cultural, and economic value through collective participation.

To realise these aims, the project followed a structured approach: first, through desk research and the identification of community members who embodied the UCB profile (primarily in informal roles), followed by focus groups in each territory. These insights fed into the development of the RegenerAction Path Handbook. In the second phase, five Local Living Labs (one in each participating city) were implemented, followed by a European Living Lab in Matera. These labs served as both experimental and pedagogical environments, where participatory methods were tested and refined. They also generated much of the content for the project's training programme, and provided the foundation for two major policy-oriented outputs: the RegenerAction Manifesto and the Policy Recommendation Paper.

By documenting this process, the article aims to contribute to ongoing debates in participa-

tory urbanism, community-based planning and policy innovation. It argues for the formal recognition of UCBs as key figures in regenerative urban processes and highlights the value of a care-based, commons-oriented and co-governance approach to reimagining our shared spaces.

Methodology

Engaging: Living Labs to engage different ways of actively thinking our cities

The Living Lab methodology is widely credited to William J. Mitchell, Kent Larson, and Alex (Sandy) Pentland at the Massachusetts Institute of Technology (MIT), who first explored and developed the concept in the late 1990s and early 2000s. Early implementations, such as the [MIT PlaceLab](#), provided controlled environments for real-life experimentation with technology and user behaviors, laying the groundwork for the Living Lab approach as a user-centric, open innovation methodology. Later on, the Finnish researcher S. Leminen discussed how the concept of Living Lab evolved, and described it as 'physical regions or virtual realities, or interaction spaces, in which stakeholders form public-private-people partnerships (4Ps) of companies, public agencies, Universities, users, and other stakeholders, all collaborating for creation, prototyping, validating, and testing of new technologies, services, products, and systems in real-life contexts' (Leminen, 2015).

Several disciplinary fields, European projects and initiatives actively use Living Labs as a core methodology to foster innovation through user-centered, co-creative, and real-life testing environments. Living Labs excel in driving actionable, collaborative urban innovation and have demonstrated significant impacts in urban planning through their emphasis on real-world experimentation, multi-stakeholder collaboration, and iterative co-creation.

A network working as a key actor to generate conversations and exchange on Living Lab best practices, success stories and learning points is ENoLL, the European Network of Living Labs.

The Living Lab was chosen as an overarching methodology of Regeneration project, as it is:

- **Multidisciplinary:** it requires the engagement of diverse stakeholders from different backgrounds - citizens, local authorities, businesses, and researchers - to collaborate intensively to design, test, and implement sustainable solutions to complex challenges. It resembles other approaches such as the Quintuple Helix Approach (promoting close collaboration between public institutions, academia, businesses and civil society), as well as the interdisciplinarity and multi-level engagement pillars of the New European Bauhaus.

- **Participatory:** at the heart of Living Labs lies the engagement of civil society for open innovation by closely collaborating with other stakeholders. Local communities are directly involved in order to ensure that the designed solutions to existing challenges are not only innovative and technologically sound but also deeply rooted in the genuine needs, aspirations, and specific contexts of the territory. This participatory approach fosters a

sense of ownership and increases the likelihood of successful and sustainable adoption.

- **Place-based:** regardless of their field of application, Living Labs strive to improve and innovate a specific place. For instance, in the urban context, a Living Lab can transform underused urban areas (e.g. green spaces or entire neighbourhoods) into more vibrant, resistant, and sustainable spaces. This transformation is often aimed at ensuring environmental responsibility through practices like circular economy, as well as at stimulating local economic development by creating new opportunities and valuing local resources. In order to achieve this, a Living Lab must be deeply rooted locally. This is why the term Living Lab often refers to the place itself and all the people that contribute to its open innovation.

The Local Living Labs

The Local Living Labs last from a minimum of 3 days to a maximum of 12 days, some consecutive and some scattered throughout a maximum of 5 months. Each partner organisation had the possibility to deal with one or more of the five spheres of the training materials: Social, Green, Digital, Communication and Planet-Public-Private-People Partnerships. A diverse cohort of 148 participants was engaged to explore principles of urban, social, cultural and environmental regeneration. All the Living Labs had to include a mix of theoretical learning, case studies, and interactive workshops that involved discussions and collaborative activities.

Seine-Saint-Denis (Paris, France), Institut de Recherche et Innovation	22	Community professionals and urban actors, focusing on the intersection of digital platforms and data democracy.
Matera (Italy), Materahub	42	Agronomists and educators, to foster dialogue on sustainable community practices in various public and private spaces.
Évora (Portugal), Arteria Lab	39	From researchers to activists, to bridge the gap between urban and rural experiences through transformative art projects.
Rijeka (Croatia), Urbani Separe	15	Architects and citizens to support an initiative opposing urban planning amendments, aiming to amplify citizen voices.
Valencia (Spain), Innohub	30	Academics, project managers, and community representatives were engaged to foster a practical synthesis of sustainability concepts.

Table 1. Number and profile of participants to each Local Living Lab.

Each lab was designed to address specific local challenges through multi-stakeholder collaboration.

Two worthwhile examples of how the Local Living Labs have contributed to local urban regeneration are Evora’s and Matera’s examples.

In Evora, the participants of local living labs created an informal group to think collectively on public space actions in the city to claim and give visibility to problems in small squares. This group still exists although it is not active at the moment.

In Matera, after the conclusion of the 8 encounters of the local living lab, a local policy recommendation paper was handed over to the local Public Administration, where the urban development office took it into consideration when planning urban regeneration

Image 1. Qualitative, textual feedback received from participants to Local Living Labs.



intervention. This synergy also led to the organisation of the local final event of Regeneration in cooperation with Fondazione Dioguardi’s ‘Cantiere Evento’.

The European Living Lab

In June 2024, an European event took place in Matera, where partner organisations and some of the Local Living Labs’ participants met to:

- **Share** the outcomes, challenges, success stories and lessons learned from Local Living Labs;
- **Explore** the Serra Venerdi neighbourhood of Matera (led by Materahub), one of the first to be built for the evacuation of people from the Sassi district. Then they used MineTest, guided by Christophe Lasserre and Natalie Quiot from O’zone architectures, to imagine regenerative actions in the neighbourhood;
- **Make podcasts** about the 5 spheres of Regeneration;
- **Co-design** a disruptive **Manifesto** containing shared intentions, concerns, desires, needs, beliefs, requests, **policy recommendations** for regenerations.

Results

Claiming: a Manifesto to question the cities of the present to create the cities of the future

Throughout the project, the partners sought to ensure that all phases were interconnected and that synergies could be established between participants in each city. Thus, as a training project, it was crucial to achieve the project’s main objectives through a common methodology—co-creation in a local living lab format, and a final European one, in which we were able to collaboratively design the principles we would like to collectively share in the project’s outcomes: the Manifesto and the Policy Recommendation Paper. The questions, demands, and suggestions contained in these documents emerge from this process of

consensus among partners and participants in the search for common elements between these cities and the actions that Urban Community Builders could develop.

Through a disruptive, critical and contributory perspective, we designed a Manifesto that can always be open, replicated and spread throughout the streets of cities as a way of demanding other futures, more sustainable, fairer, more democratic, less extractive and more shared.

Through the artistic mediation of Miguel Januário (a Portuguese artist and designer with a strong background in urban art in public spaces with a political nature), all partners and participants in the local living labs were invited to contribute to this collective process about each of the cities involved in the project: Paris (FR), Matera (IT), Valencia (ES), Rijeka (CR) and Évora (PT) as starting points for finding the common messages of this Manifesto. During the European Living Lab, we created a movement associated with this Manifesto that could continue after the end of the project that gave rise to it: RGEN - the R generation, from RegenerAction. This first collective moment resulted in the basis of the Manifesto, the main issues related, mostly, to the sharing of public space with other inhabitants (trees, animals, etc.), housing, the crisis and climate justice in cities, as well as policies for welcoming and integrating new residents and communities. In addition to the main contemporary issues identified in common, this workshop made it possible to define that this manifesto would have a guerrilla character, that it could be easily replicated by anyone, anywhere, and that it would spread throughout cities as a way of giving visibility to these challenges and an appeal for cities to be thought about together, not only among local communities but also with local authorities and decision-makers.

The manifesto's central themes emerged from the acronym RGEN: Resist Commodification | Grow Relationships | Embrace Nature | Nurture Commonality. From these four main axes, three more specific demands are derived, which are presented as the first version of a manifesto that can continue to grow and receive contributions. Many of these

Figure 1. Manifesto Posters in English (Miguel Januário)



moments of gathering ideas for the Manifesto take place in public, street-based initiatives, in which we invite people to think about what they would like for their cities. The whole Manifesto was translated into english, portuguese, spanish, french, italian and croatian.

Decision-Making: a Policy Recommendation Paper for common challenges

In order to provide intelligibility at the level of public policies that emanates from the project's MANIFESTO itself, also inspired by the training program developed by the partners, a public policy document was drawn up that could suggest some paths towards preparing our cities for the future. As part of the project's final event, which took place in Évora at the Celeiros space (a cultural space in the city that hosts groups of artistic agents), the participants (many of whom had already participated in previous initiatives of the project, such as local living labs) took part in a series of simultaneous workshops in which the processes of expectant places in cities were discussed in four main dimensions: Urbanism, Communities, Activation/Communication and Governance. The final sharing of each participant was also very relevant to nourish the final version of the document. The main goals of this document were to present a set of proposals for general public policies regarding the way we would like to live our cities and territories and also proposals for amplifying the different voices that constitute our communities: human inhabitants, new residents, bio- and geo-diverse forms of life and matter in a collective and common approach. This policy recommendation paper also serves as a tool for intervention and mediation that can be developed through the action of profiles such as urban community builders, giving tangibility to the needs, appeals and dreams of the different communities of a given territory/city. In this case, we rehearse the process of transforming the protests of a manifesto into possibilities for action, for RegenerActions. Some examples of this process are:

- a) Resist Commodification: We need space to make dreams come true. Create socialization zones in public spaces not dependent on consumption or negotiate the existence of free socialization zones in the concession contracts of esplanades and terraces (...)
- b) Grow Relationships: We miss being with each other. Create legal and management mechanisms that facilitate temporary occupations of outdoor public spaces with cultural, educational and circular economy activities organized by informal groups or community members;(...)" (Policy Recommendation Paper, available in <https://regeneractionproject.eu/resources/> , p. 4-9)

Discussion and Conclusions

The Urban Community Builder can be described as an ecological figure. The term ecological is used here in the sense given by Guattari in the book Three Ecologies (1989). As he argues, the world we live in today, as well as the ecological state of emergency it is in, can't be fully understood - and therefore tackled - without taking into account the broadest of human agencies. In order to address the interconnected crisis facing humanity, a holistic approach is needed. Guattari also emphasizes the importance of urban areas, being intertwined with the natural world, in bringing about needed change. It is in cities that challenges arise, solutions are implemented, and changes are felt by most.

As understood in this project, regenerative processes respond to social, urban and environmental needs perceived as urgent by the communities, with which the urban community builder, in their role– whether as an active citizen or as a professional profile, cooperates and interacts.

As this is still a recent profile in the development and implementation of public policies and urban planning in cities, projects like this are important for the visibility they give to their role within communities, identifying challenges, and planning actions that can influence political decision-making processes, but also amplify the voices of all their inhabitants. Therefore, we believe it is crucial to continue working and empowering more people to share tools and resources, as one of the potentialities of UCBs' work. Individual UCB profiles can be more demanding, however, as this is a transdisciplinary effort that requires teams with diverse backgrounds. It is important to raise awareness within formal and informal collective structures, as well as within the public sector, regarding the professional integration of these teams. In this sense, we believe they can be important agents of intervention and influence in the definition of other forms of governance, particularly within the urban commons framework. By presenting the process developed within the scope of this project, we want to contribute to thinking about the actors, mediators, activators and agents essential for the co-design of public and common spaces. We also want to share the experience of a process and methodology that sought to expand participatory practice to different spheres and layers not only of civil society but also of decision-making entities.

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NATURE

Sustainability and climate adaptation challenges are increasingly shaping the organisation and planning of urban areas. Creating space for permeable surfaces, vegetation and trees, adequate soil conditions, and dynamic stormwater basins plays a key role in this process, contributing to improved air quality, noise mitigation, and the reduction of urban heating.

The selected articles within this thematic dimension stress that street transformation makes evident that enhancing urban resilience requires a careful assessment and deep understanding of existing ecological systems and their interdependencies.

Technical and design knowledge becomes a requirement for the transformation of streets into 'green spaces', which entail strategies and project solutions for integrating natural systems with the infrastructural dimension of streets. Considering the limited available space, which must also provide space for social interaction and mobility, the natural part of streets faces serious challenges.

The articles show various methodologies for the assessment and selection of urban tree heritage, reinforcing its role and reframing it as a form of essential infrastructure. Criteria for species selection and spatial dimensioning are established, allowing vegetation to move beyond a predominantly decorative or aesthetic role and acquire greater precision within intervention processes. In this way, the articles underscore the fundamental importance of natural systems in supporting urban adaptation to a new climatic context.

Rethinking significant streets as an essential part of the ecosystem structure of cities: Components and relationships in the current context of climate emergency

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Abstract

Nowadays, talking about streets is fundamental, because we could consider them the main spatial resource of cities to be able to correct economic and social inequalities, and fight against climate change, but also to balance urban territories. Heat islands, poor air quality, biodiversity loss, and excessive road mobility, among other factors, increase air pollution levels and the local effects of the climate emergency in cities of the global south. The aim would be to characterize the set of components that make up their ecosystemic spatial networks to help reverse these processes. In this way, research is oriented towards urban policies - and designs - to increase urban resilience along these lines.

We will discuss 'meaningful streets,' which assume significant urban responsibilities for mobility, as well as economic and identity considerations. To identify them, we must consider those urban thoroughfares that now uphold a balance among the historical, contemporary, and future aspects of the city, both functionally and aesthetically. This approach aims to comprehend the potential of the city's spatial, morphological, and geographical assets, including public and open spaces, urban infrastructure, the realm of urbanization, and the interconnections between systems.

The identification of the variables and urban facts around the significant street with ecosystemic and eco-social potential is carried out through two lines of work: (1) the inventory of the urban-ecological elements, and (2) the future urban planning of the identified systems, the approach to the formulation of criteria, and intervention guidelines. The objective would be to underline dimensions of the street to be reinforced, as well as urban elements of its ensemble with high ecosystemic potential. For all this, the research is guided by the principles of sustainable mobility, urban proximity, as well as by commitment to ecological connectivity and the networking of urban public spaces from an eco-social perspective.

Keywords

urban design, city street, ecosystem structure, green infrastructure, public space

1. Introduction

1.1.The loss of urban resilience

The local effects of climate change, the increase in urban temperature, heat islands -product of the form of urban development of cities-, cross the major cities (Garcia, 2022). This does not affect only Andalusia but is framed in a context that affects the whole of Mediterranean Europe, causing, in addition to the deterioration of environmental quality, urban health problems of all kinds (Viegi et al., 2020; Nastos & Saaroni, 2024). Thus, also, as Garcia and Diaz (2023) point out: “Life in the Mediterranean is predominantly outdoors throughout the year, which exposes its inhabitants to an evolving climate, progressively harsher and punctuated by increasingly frequent extreme weather phenomena”. As a result of this, and their own urban configuration, four Andalusian capitals are among the nine cities most polluted by nitrogen dioxide, and Granada, Malaga, Seville and Cordoba, have exceeded in 2024 the new legal limit of pollution by this component (Ecologists in Action, 2025).

As we can observe in Figure 1, there could be a decrease in the rain and desertification in the Iberian Peninsula. Areas with black dots indicate that changes are not significant using a two-sided Student’s T-test at the 95% confidence level. The spatially averaged changes over Spain are shown in the bottom right corner of each panel. The average annual rainfall could decrease by up to 42% by the end of this century because of climate change.

If we look at the case of Granada, the city has one of the highest levels of air pollution in Spain, on a par with metropolises such as Madrid and Barcelona. This is due to a very high rate of metropolitan motorization and to some specific geographical and economic factors (Polo-Villanueva, 2021), according to the 2020 Report of the Observatory of Energy and Sustainability in Spain.

Despite this, municipal administrations often have an outdated approach to urban planning or superficially address the issue of the necessary naturalization of cities. Based on this reality, the essential issue would be the adaptation of cities and the improvement of their urban resilience, transforming them from their existing structure and turning this into an opportunity.

This new urban formulation involves the categorization of components of a new ecosystemic structure, in application of the objectives of sustainable development, incorporating a multidimensional vision, prioritizing the naturalization and improvement of the urban environment and connectivity, but also incorporating social, cultural and historical dimensions, and relating to the balance and promotion of urban functions that favor social cohesion.

1.2.Significant streets and the city’s ecosystem perspective

The proposal focuses specifically on “meaningful Streets” or “outstanding streets” as the main spatial resource for so many cities affected by the climate crisis in the global south. These fundamental urban axes, which cross and articulate cities, assume important urban

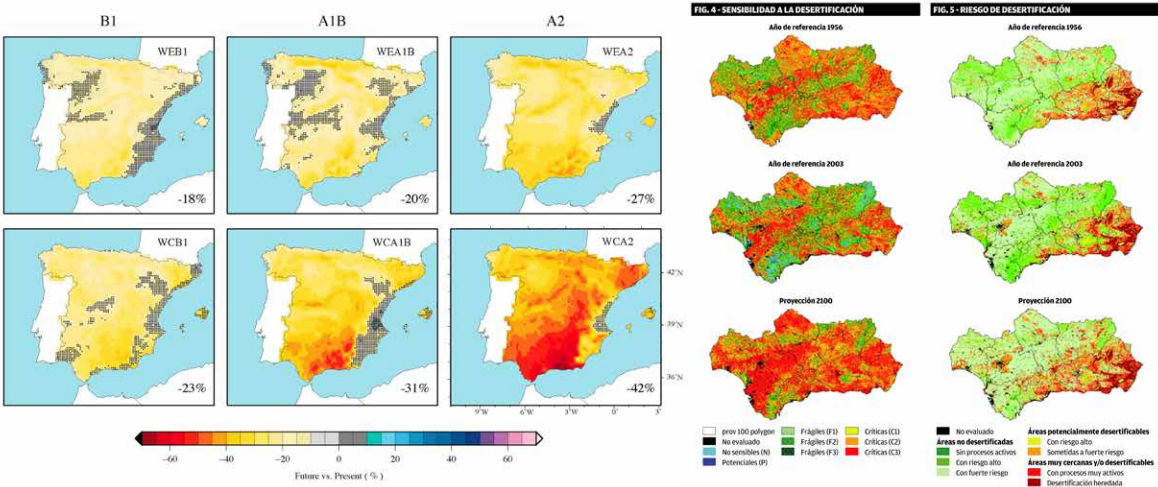


Figure 1. (Left) Projected changes in the annual mean precipitation (2070–2099 versus 1970–1999) for the different WRF simulations; (Right) Desertification Sensitivity and Desertification Risk. Source: (Left) From Argüeso et al. (2012: 6); (Right) From Moreira & Rodríguez (2008:20).

responsibilities in terms of mobility, as well as economic and identity considerations, closely linked to the essence of the city. To identify such notable streets, we must consider those urban thoroughfares that now uphold a balance among the historical, contemporary, and future aspects of the city, both functionally and aesthetically (Rivas-Navarro, 2015).

Focusing on the major streets of urban forms, the aim would be to explore and characterize the set of components that currently make up their ecosystemic spatial networks to help reverse these processes. Observing their characteristics in the current context of climate emergency relates to the concept of green infrastructure (Benedict et al., 2006). In this way, research is oriented towards urban policies - and designs - to increase urban resilience along these lines. The underlying goal is to combat the urban heat island phenomenon, among other environmental problems, at the local level of the street’s relationships, and to transform cities into climatic refugees and circuits for ecological interconnection and biodiversity enhancement.

The question would be, assuming the methodological framework of the root research, to highlight the urban elements with high ecosystemic potential for the future of Granada around its main streets or structuring roads, through the selection of specific study sites, their typification and the re-reading of the urban plots.

How to make green infrastructures more resilient in the face of the urban heat island phenomenon and refuge for biodiversity?

The objective of the framework research would be to identify the elements of the city and its surroundings that would, in turn, make up the ecosystem structure of Granada. The research work is based on the prospective vision of the metropolis, considering public and private spaces as functional elements of a complex system of overlapping scales, focusing on improving the quality of life and the health of its citizens. There are numerous examples of urban policies or projects that address improvements from an environmental perspective or are presented as green infrastructure. On the other hand, the definition of necessary ecosystem elements or indicators has been addressed by numerous studies. This proposal incorporates research through the project so that the specific case study helps to define

the components cartographically and conceptually and outlines a roadmap for obtaining a guide to sustainable urban projects that will enable viable transformation interventions to be carried out in the future.

2. Methodology

The research is being conducted using the city of Granada as a case study. Camino de Ronda street is specifically the tested hypothesis of a significant or main street in its central urban morphology (Rivas-Navarro, 2015). The following fundamental steps are presented for its development, along with the methods applied in each one:

1) *The development of an ecosystem map for the city of Granada*, based on the creation of a legend of ur-ban components with ecosystem potential. To achieve this proposal, a study is being conducted of cities in Spain and internationally that have implemented policies or plans for green infrastructure, biodiversity, and the promotion of ecological and resilient structures. At the same time, theoretical re-search has been carried out in the disciplinary literature on ecosystem urbanism, covering dimensions and indicators that were compiled in the study of cities.

2) *The city street as an operational tool with greater spatial and relational potential*. The starting point is the spaces and streets of the system defined as the “city street” of Granada, which is contrasted with ecosystem mapping. To this end, the integrated mobility and morphology analyses of the significant Camino de Ronda street are recovered, and the process of verifying the ecosystem potential of its components based on the proposed general mapping is initiated.

3) *Key locations for sustainable and ecosystem urban projects*. The third step, which is only approximate at this stage of the research, is to identify a series of key locations for implementing urban transformation policies and interventions that exemplify spatial opportunities within the urban system under study.

This methodological structure is presented in greater detail below, prior to the presentation of the results obtained from the first and second steps, as well as preliminary results from the third step.

2.1. Case study

The city of Granada is part of an interesting regional and geographical context from an ecological point of view. Its study is particularly necessary in terms of the impact of climate change on city interiors, as already noted. Granada, as the capital of an inland province in the eastern part of the region of Andalusia in southern Spain, is integrated into the Mediterranean context with its own territorial, historical, economic, cultural, and social characteristics (Rivas-Navarro, 2015). It is a city shaped by hydrological and agricultural logic, with defining historical features, including its Nasrid past and the Christian

Reconquista. In the 19th and 20th centuries, urban development has been marked by local economic and de facto powers (unlike, for example, Malaga—another provincial capital in Andalusia—which always had external interests). Its alternating periods of urban transformation and planning immobilism have always gone hand in hand with a privileged geographical location along-side enormous economic difficulties and nepotism in governance (Parcerisa-Bundó, 2012). The metropolitan urban area, organized around the city and comprising more than 30 municipalities, generates increasing private mobility that the city needs to manage with very little road space (Gómez-Ordóñez et al., 2010).

On the other hand, serious environmental problems resulting from geographical depression and the lack of large public spaces to counteract the heat island effect in the summer months have already been discussed (Polo-Villanueva, 2021; García, 2022).

From an urban planning perspective, the city lacks a green infrastructure plan (unlike other cities in Spain over the last two decades -Vitoria (2014), Madrid (2017) o Barcelona (2020), among others-). It also failed to implement at least one urban tree management plan, which is present in nearby cities such as Seville (2019) and Malaga (2017). These characteristics relating to governance, lack of urban environmental planning, and problems of mobility, air pollution, and heat islands are the motivation for this research. The aim would be to put forward a consistent approach to mapping that highlights elements with ecosystem potential in order to guide future actions, policies, and sustainable urban projects

2.2. Definition of ecosystem mapping

Phase I: Analysis of primary sources (Literature Background and Laboratory of Cities)

Primary Source I - Theoretical Approach. The first phase consists of a theoretical approach to the ecosystem city, as a project, based on several categories of urban elements with ecosystem potential. Recognizing urban identity as an essence that is renewed and constructed precisely through human decisions, it is worth asking about the urban elements or concepts that give meaning to urban identity (Rivas-Navarro, 2009). Un amplio espectro de referencias disciplinares fueron utilizadas para cubrir las dimensiones y variables consideradas en la consideración de los tópicos Urbanismo Ecosistémico, Urbanismo Ecológico, Infraestructura Verde, Sostenibilidad y Resiliencia Urbana.

Primary sources II - Study of real cases. It consists on the study of cities that show in their urban planning an eco-system commitment with the logic of their existing fabric. The primary capital for improving urban ecosystems and green infrastructures is open urban space, particularly public space. Evidence for this is his view of the interrelated components that guide the integration of sustainable urban development into the New Urban Agenda (United Nations, 2017), and the central role that public spaces play in social and economic development (Mehaffy et al., 2019). A relationship is established between the analyzed

Cities Laboratory and the dimensions and variables considered in each of them, and it is cross-referenced with the categories designed in the theoretical approach (Rivas-Navarro & Bravo-Rodríguez, 2025).

Phase II: Building of the cartography's legend and Urban Purpose.

With the aim to obtain a new image meaningful of the city, territorial resources, current ecosystem services and potential green infrastructure are carefully identified and categorized at that second phase, considering elements from the city and its surroundings. We would be discussing a very extensive inventory or compilation of urban components that would include almost all the unbuilt areas, the biological matrix of open spaces, which must be viewed as a single interconnected system (Rivas & Bravo, 2024), as can be seen in the environmental and urban planning and policies of the cities taken as references. The “cataloguing vision” is essential for establishing the set of urban facts that must be considered, generating typologies of urban elements that construct ecosystem mapping. This descriptive culture must be combined with an “architectural vision” or long-range project, in terms of operability and use (De Solà-Morales, 1981).

The Ecosystem structure for Granada is revealed using two complementary perspectives: (1) the registration of urban-ecological elements belonging to the founding of the original settlement; and (2) the consideration of future urban projects and urban policy logics to identify possible systems and urban patterns according to sustainable development. The research presented here advances with the proposal to represent an exemplary window of the city of Granada, from the first perspective, and, considering the composite system of the significant street selected, makes a preliminary approach to the second perspective.

2.3. “City street” as a fundamental spatial resource for ecosystem mapping

The section as a cartographic tool has the enormous quality of relating different places of the plan through the idea of cutting, an action that reveals both the internal organization of the fabrics and their global urban form (De Solà-Morales, 2008; Rivas-Navarro, 2015). The “urban cut” -understood as an operational selection of the city map-, would behave as a descriptive instrument, a “conceptual traversal” of urban reality that allows to guide the action of looking, collecting and describing. The selection highlights specific elements and incorporates other social aspects, iconography, texts as well as influence our understanding of the observed area of the city.

Furthermore, the concept of “mental map” was superimposed, as topology to produce diagrams. The mental map was part of the language of architecture that emerged after post-structuralism (Verga, 2006). The mental map has its origins in Lynch's (1970) “environmental image.” It is defined, and can be defined, as a generalized mental picture of the outside world retained by an individual: “the product of both immediate sensation and the memory of previous experiences (...) to interpret information and guide action” (pp. 12-13).

This meant accompanying the significant street in question from the set of places, public

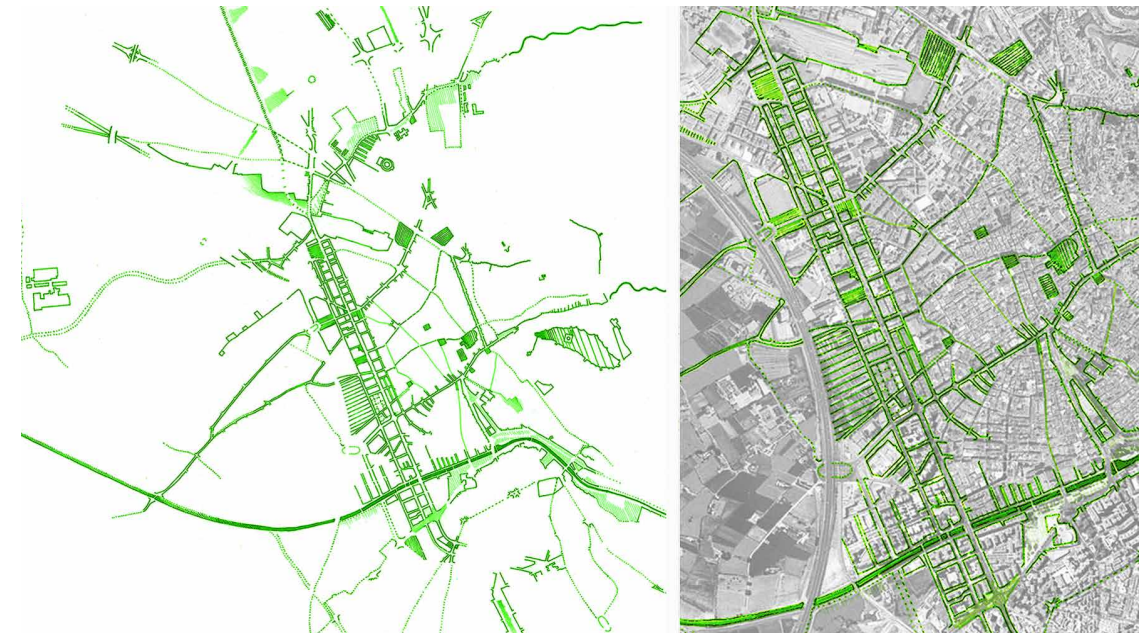


Figure 2. Superimposition of the City Street on the orthophotography taken from Google Earth of the year 2000. Relational structure with ecosystemic potential as a starting hypothesis. Source: Adapted from Rivas-Navarro, 2012.

spaces, relevant facilities, and other secondary streets—parallel and transverse—that intersect with it. This set of interrelated elements, forming an inseparable part of it, is called the “urban street universe.” (Rivas-Navarro, 2012). As a starting hypothesis for research, the street and its urban universe end up polarizing the city and allowing for a hierarchy of places within the city crossed by the relevant street (see Figure 2). This set of components must first be verified regarding their ecosystem potential so that, thanks to this identification, policies or transformation projects can be guided.

This composite urban form would extend beyond its immediate urban boundaries, edge blocks, or nearby urban fabrics or grids. They constitute, as Steven Holl defined it, a “paralactic” space (1996, p.12), in which many elements and dimensions gravitate functionally and visually around it, including the geography, history, and landscape of that city.

3. Results

3.1. Integrated analysis of the urban form of the significant street

The aim would be to analyze the road section of the street according to the type of integrated analysis carried out two decades ago in the Report for the Feasibility of the Camino de Ronda to plan the surface or under-ground passage of Line 1 of the metropolitan tramway. When analyzing mobility and traffic flow, it is essential to consider all the streets that run alongside the central street in question in a north-south direction. In this way, it is possible to: (1) assign the essential traffic lanes in each street; and (2) detect the left and right turns that are mandatory for the proper functioning of the system. With this, it is possible to find out to what extent to increase, in general, sidewalks and pedestrian crosswalks, increasing the options of the natural potential at the edges of road sections (see Figure 3). The purpose would be to identify traffic priorities, establishing minimum requirements in terms of the



Figure 3. (From left to right) (1) Cross interference with the direction of the main axis (West-east direction); Cross interference with the direction of the main axis (east-west direction); Road capacity of the composite section of the system. Source: Adapted from Gómez-Ordóñez et al., 2010.

number of traffic lanes, mandatory public transport routes, loading and unloading traffic, etc. Likewise, identify all secondary streets in the system that could do without this vehicular traffic to promote pedestrianization, increase walkable areas, expand sidewalks, create green spaces, increase drainage areas, and increase tree planting.

In the integrated vision of the complementary streets of the Camino de Ronda, we propose as a method the identification of a model that assigns differentiated roles to the main transversal streets (mixed mobility, central and multifunctional axes vs. green, pedestrian and cultural axes). It is understood that the longitudinal force of the public transport that was in question, subway or on the surface, must be complemented by a gradual intensity of the transversal link movements that connect with the stations or stops. At the same time, the incorporation of the light rail, whether above or below ground, must be accompanied by the pedestrian diffusion of stop locations. This mechanism serves as a guide for establishing not only the walkability of this local dissemination network, but also the project that specifies the increase in the ecosystem capacity of the public space of the system referred to as the “city street,” as a key spatial resource within cities (see Figure 4).

3.2. Spatial categories with ecosystem function

The proposal for the construction of a Cartography of Granada through an ecosystemic approach is made by selecting a transversal window of reference that can address most of the urban casuistry that occurs in a city like Granada. This includes a renewed vision of major urban thoroughfares, including, on this occasion, the case represented by the Camino de Ronda.

After the corresponding tables in relation to groups of elements with ecosystem potential were compiled, several initial criteria for spatial categories spaces with eco-system functions were systematized (Rivas & Bravo, 2025). The question was how to organize the



Figure 4. (From left to right) (1) Pedestrian diffusion around the light rail stops; (2) General pattern of urban relationship (mixed mobility axes vs. cultural axes); (3) Relative importance of cross-cutting encounter. Source: Adapted from Gómez-Ordóñez et al., 2010.

Table 1. Components of Foundational Traits category (blue color range) of Granada's ecosystem cartography design.

FOUNDATIONAL TRAITS (blue color range)		
Subcategory	Component	Description
RIVERSCAPES	River axis	The actual riverbed along which the rivers run
	Nearby extension	Space adjacent to the river that is understood as part of the riverbank
	River frontage	Frontages of buildings that have a direct view of the river
	Tributaries Street	Streets perpendicular to the river
	Urban basin of the crossing	Space adjacent to the river course
	Confluence nodes	The point where two river axes meet
WATER CULTURE	Bridges	
	Irrigation ditches	
	Fountain	
	Runoff	Land through which rainwater circulates freely and naturally.
	Private swimming pool	
	Others:	Washhouse, Water reservoir

Table 2. Components of Urban Fabric category (red color range) of Granada's ecosystem cartography design.

URBAN FABRIC (red color range)		
Subcategory	Component	Description
FABRICS OF THE MAJOR CONNECTORS	Historic roads	
	Ecosystem axes	Axes with maximum ecosystem potential
	Efficient axes of traffic flow	
	Pedestrian parallel axes	
STRUCTURING AXES AND THEIR INFRASTRUCTURE	Historical gates and walls	
	Railway and railway station	Railway line and its stops
	Granada's Beltway	Roadway system transition to the Vega, motorway that cuts the connection between the city of Granada and its Vega
	Light rail	
STRUCTURE OF PUBLIC LAND	Cycle lane	
	Urban block	
	Parcels	
	Sidewalk / Driveway	
	Road or mixed street	
	Pedestrian street	
	Linear walkways	
BUILDING	Squares	
	Residential building	
	Urban facilities	
	Non-residential function	Large commercial area; large industrial areas

set of urban features into three major structures or groups of urban facts related to three cartographic moments: (1) foundational traits (the legacy of the past); (2) urban fabric (the concerns of the present); and (3) green infra-structure (the planning future). By reading the compo-nents included in each category, the implications for ecosystem resilience of each category can be understood. This is detailed below, along with the list of starting compo-nents (see Figures 5, 6 and 7).

I. **Foundational traits:** It involves identifying and representing primary elements of natural origin with ecological potential; we are referring mainly to river or water areas, which are basic conditions for settlement. The places reflected in the blue color series refer to the reinforcement of riverbanks, the protection of water heritage, the increase in associated vegetation, and the creation of public spaces related to buildings participating in the urban or agricultural water cycle.

II. **Urban fabric:** It involves identifying and representing the built urban fabric that has transformed the territory to date. We are talking about the red chromatic network, which is mainly made up of streets and blocks, grouped into fabrics and broken down into smaller elements (sidewalks, roadways, types of buildings according to their function, etc.). Ecosystem potential refers to the transformation of roads, pedestrianization policies, street tree planting, courtyard conversion, but also options in private and covered open spaces, party walls, and facilities, mainly.

GREEN INFRASTRUCTURE (green color range)	
Subcategory	Component
FREE WALKABLE SPACE	Public green space
	Riparian vegetation
FREE SPACE NON-TRANSITABLE	Public space vegetation
	Vertebral axes vegetation
THE PRODUCTION SPACES	Agricultural plot and nursery
	Pedestrian path
GREEN MOBILITY	Linear/river walkway
	Cycling route
BIODIVERSITY	Vegetation and tree cover
	Permeable surface
FREE SPACE ATTACHED WITH POTENTIALITY	Private Free Space

III. **Green infrastructure:** This is the category most directly connected to the ecosystem network. It is based on the green color system. It consists of the collection and diversity of public open space, non-motorized mobility, natural spaces or urban forests, peri-urban and agricultural areas. Increased ecological connectivity and biodiversity, improved environmental conditions, tree planting, soil drainage, and the design of green spatial networks are the main lines of work with this set of elements.

3.3. Aproximación al proyecto urbano sostenible y ecosistémico del Camino de Ronda en Granada

If we move westward in the initial window approached, we can focus our gaze on the contact between city and central Vega, placing the analysis in the territorial position of the exit of the fluvial system of the Genil river from the urban area to the agricultural area of the Vega (see

Table 3. Components of Green Infrastructure category (green color range) of Granada's ecosystem cartography design.

Figure 5. (left) Cartography of the laboratory framing of Ecosystemic Granada as opposed to current orthophotography taken from Google Earth. Own elaboration.



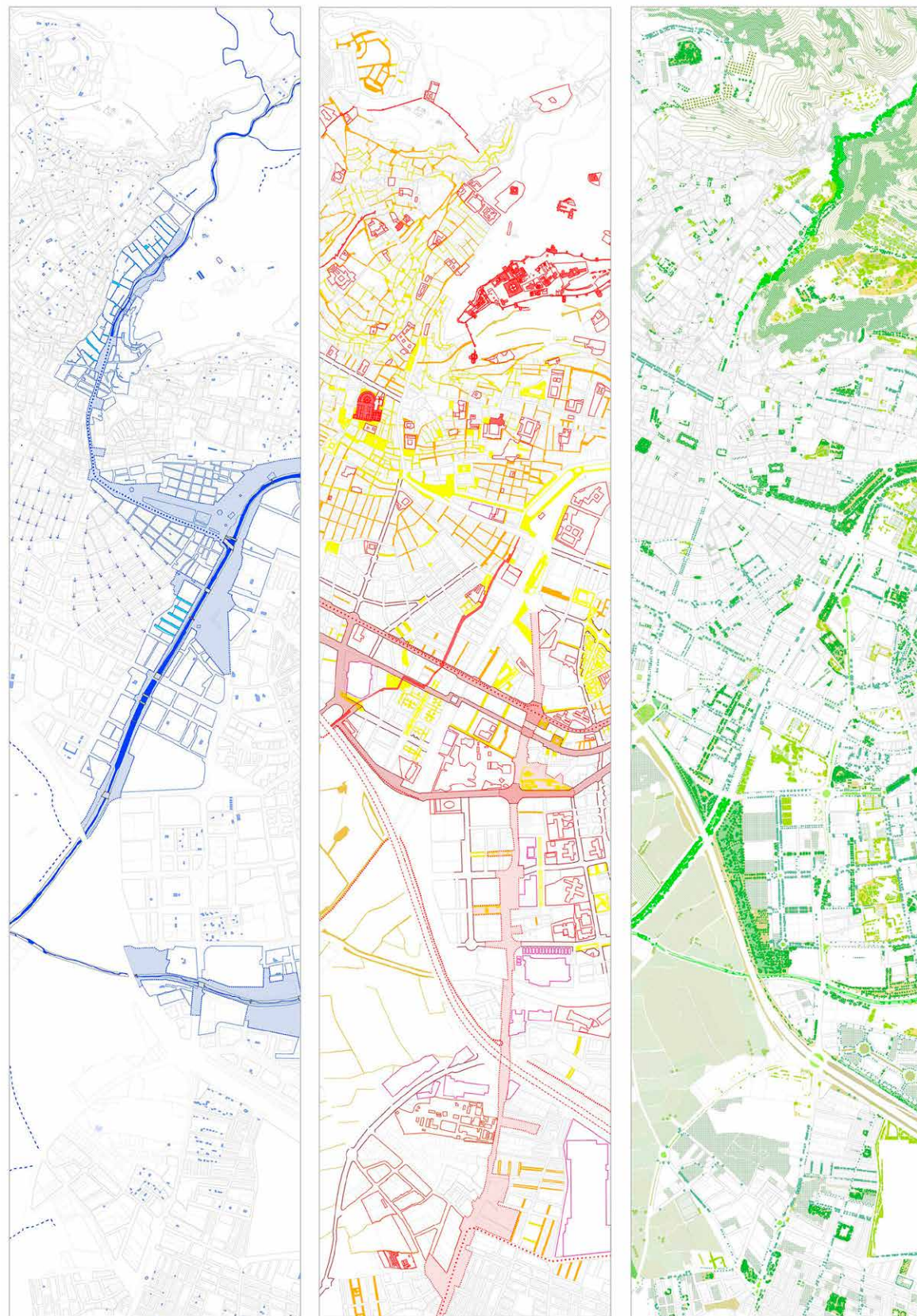
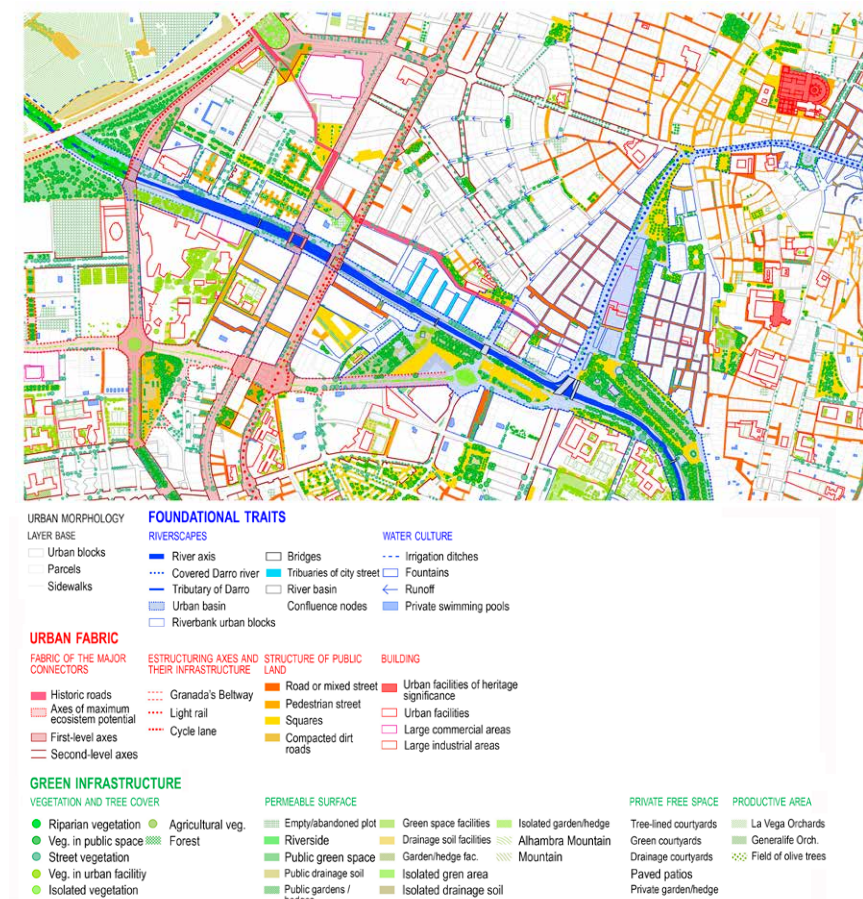


Figure 6. Three categories of Granada's ecosystem cartography approach (From left to right: Foundational traits, Urban fabric and Green Infrastructure). Own elaboration.

right side of Figure 2). In this closer framework, both the development of the riverbed and the traditional relationship between the city of Granada and the municipality of Armilla and other ones that go deeper into the Vega de Granada are established in an east-west direction. Both east-west linear systems cross the north-south system of streets and avenues that have in the Camino de Ronda the main axis, the street-city of Granada (Rivas-Navarro, 2015). The pedestrianism that could arise from a “calm and environmentally improved environment” of the Genil, would also be key when recon-sidering certain axes that connect the banks with more inland positions (especially if these streets can also connect with public facilities of all kinds, in an ecosystem sense and in terms of strengthening biodiversity and ecological connectivity.

The value of space in the large streets and arteries of vehicular traffic in this western frame of the initial win-dow addressed is also fundamental, both in qualitative terms—due to the number and intensity of urban relationships generated by the relevant street—and in quantitative terms—due to the amount of space available on the main axis, wide sidewalks on complementary streets, and public spaces connected by this complex urban sequence. We are talking about ecosystem operability that would take place in specific locations: large sidewalks and their continuity are a first level spatial resource for tree planting and the improvement of temperature, humidity and biodiversity connectivity conditions. This is

Figure 7. (top) Partial framing of the southern area of the Camino de Ronda; (bottom) Legend of the three categories for the cartographic proposal. Own elaboration.



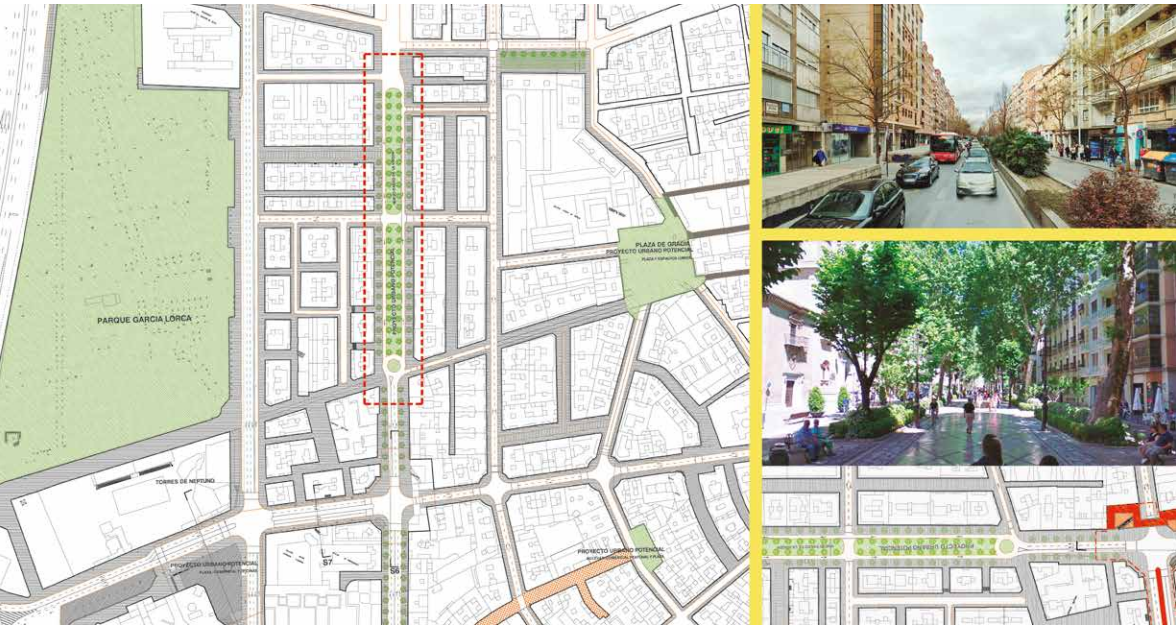
particularly important here, in the interior context of the city, where the streets cross a space that we could consider an “ecosystem node” of mapping such as the urban fabric around the river environment. Its status as a node would come both from its central location in the morphology of Granada and from its capacity to coordinate public policies and readjust existing areas, in the sense that Gouverneur calls “informal supports” (2015).

The opportunity presented by the cut established by the significant street system on the proposed ecosystem mapping is to focus on types of urban spaces and situations that serve as a guide for the development of specific sustainable urban projects. Considering the hierarchies established by the composition of the city street (see Figure 2) and the

CATEGORY	OBJECTIVES / SPATIAL TYPOLOGY	LOCATION IN THE URBAN SYSTEM OF CAMINO DE RONDA STREET
FOUNDATIONAL TRAITS	1. Pedestrianization, drainage systems, tree planting, and increased public space along urban waterways	Square on the Genil River, intersection of Arabial and Jardín de la Reina streets
	2. Narrative walking and cultural itineraries along historical routes (streams, tributaries, urban irrigation channels)	Crossroads Camino de Purchil, Plaza Menorca, Obispo Hurtado, Tablas; Ancha de Gracia y Virgen de Gracia streets.
URBAN FABRIC	3. Reconsideration of the urban section on the main axis, increase in pedestrian space, drainage flooring, and tree planting.	Section of Camino de Ronda between Calle Recogidas and Camino de Purchil (New Paseo de la Virgen, see Figure 8)
	4. Pedestrian network around subway stations	Square on the Genil River; Station at Recogidas and Einstein square; Intersection with Camino de Purchil
	5. Creation of superblocks and local walkability environments	Selection of interior streets in superblocks, dispensable for vehicular traffic
	6. Healthy school environments and community urban facilities	Educational, cultural, social, and health facilities in the street-city system.
GREEN INFRASTRUCTURE	7. Improvement and strengthening of public free spaces (tree planting, drainage, connections between spaces)	Network of main and secondary green spaces (García Lorca Park, Menorca Square, Gracia Square, Einstein Square, Fuentenueva/Campus, green spaces on sidewalks along major roads)
	8. Urban riverside park	Urban environments of the Genil River and Beiro River
	9. Increased tree cover and well-drained soil	Sidewalks along the main axis and structural axes such as Calle Arabial, Calle Severo Ochoa, Carretera de Armilla, and Avenida América

Table 4. Approach to the sustainable urban project for the city street system in the proposed ecosystem map for Granada.

Figure 8. “New Paseo de La Virgen”: A pedestrian walkway on a section of the Camino de Ronda in the context of strengthening the walkability and the ecosystem potential of the section. Source: Adapted from Gómez-Ordóñez et al., 2010.



categories organized in the ecosystem legend, an approximation of this operational guide for intervention is provided below (see Table 4).

In the urban fabric category, one of the actions is exemplified by the reconsideration of the Camino de Ronda section itself and taking advantage of its spatial offer. Its objective is to organize parking, increase public space and tree planting, with the consequent improvement of environmental quality and the role of the ecosystem node of the main street of the system (see Figure 8).

4. Conclusions

The results show the following main findings: (1) the capacity of the significant street system to participate in the set of categories proposed for redesigning the city plan, both because of its large spatial offering and its intense network of relationships between urban elements; (2) The main urban situations within the city of Granada coincide as fundamental articulations of the “city street” system, so addressing these situations is very efficient in terms of sustainable planning effort investment; and (3) Dimensions such as mobility—including public transportation—and the gathering of people in urban community facilities are characteristics that make the street system relevant as a social and economic articulator; this motivates and justifies the ecosystemic interventions proposed by cartography.

The streets of the city are not only a space for potential changes in their section or interior surface, but they are also a key part of its urban structure, its cultural meaning, and urban history. This becomes crucial when talking about significant streets. Approaches should always be performed from overlapping perspectives and dimensions that integrate the whole of relationships and consider urban identity and landscape links as well.

The fight against climate change takes place in the urban scenarios of the city, and the spatial dimension of physical resources plays a fundamental role as dissipator, enhancer, blocker, or enabler of urban strategies of more positive response of cities to local effects of the climate emergency.

The aim is to prepare future reflections and interventions involved in a real possibility to tackle serious environmental and health threats. The focus would be mainly to understand the spatial and urban ability of the city to strengthen itself eco-systemically, preparing for real policies of decarbonization and improvement of urban health and well-being of people.

The approach of mapping of the Granada with ecosystem approach is just a starting point. The possibility that it is opened would be to establish an eco-structure that implies a lot of urban fabrics and the assignment of different roles to urban facts (streets, blocks, public space, collective facilities, etc.). Future lines of research should focus on quantifying spaces with potential for transformation, as well as measuring actual starting points and comparing them with environmental improvements brought about by the proposed environmental policies (humidity, heat island/temperature, air pollution, pedestrian and bicycle traffic, tree cover, among others). The typology of intervention spaces should be developed with more

practical examples based on the standard urban project, building a useful palette of future interventions.

The urban design of the city street, as a significant street of the moment, as defined in the foundational research cannot be isolated or removed from this profound understanding of its urban form and its functions. The Urban Design will be determined and precisely dimensioned and adjusted by this careful and thorough obser-vation of the complexity of the street.

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Street tree characterization and selection for urban environments: a case study in Matosinhos and Leça da Palmeira (Portugal)

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Abstract

Street trees play a critical role in urban environments, contributing to climate regulation, air quality improvement, stormwater management, and biodiversity support. They also enhance public space quality, pedestrian comfort, and help mitigate the urban heat island effect. However, their ability to deliver these benefits depends on their size, structure, and spatial arrangement.

This study characterizes the street tree population in Matosinhos and Leça da Palmeira (Portugal), analysing species diversity, attributes, and spatial distribution patterns based on a municipal tree inventory of 5,813 trees from 110 species. Results show a substantial proportion of small-sized species, which have limited capacity to provide essential ecosystem services compared to larger trees. While some streets feature larger, structurally robust trees, many rely on smaller ornamental species that offer aesthetic value but are less effective at providing shade, regulating temperatures, and sequestering carbon.

Species distribution patterns reflect both cultural and environmental factors, with coastal areas showing a higher prevalence of wind- and salinity-tolerant species such as *Metrosideros excelsa*. Species like *Platanus × hispanica*, *Populus nigra*, and *Ulmus minor* are more broadly distributed, demonstrating resilience in both coastal and inland areas.

To guide future urban forestry practices, the study proposes a framework for selecting trees based on the ‘minimum street tree’ concept, which balances ecological performance with the spatial constraints of urban streets. This research underscores the importance of aligning tree selection with site-specific conditions, advocating for increased tree size, species diversity, and resilience to enhance the long-term benefits of urban green infrastructure. By integrating ecological knowledge into street design, urban planners can foster more resilient, climate-adaptive, and liveable urban environments.

Keywords

Urban trees, minimum street tree, urban green infrastructure, climate adaptation, public space quality

Introduction

Street trees are vital components of urban infrastructure, offering a broad range of ecosystem services that enhance city resilience, environmental performance, and quality of life. Their integration into streetscapes contributes to the regulation of microclimates, interception of stormwater, improvement of air quality, and support for biodiversity and ecological connectivity (Nowak & Dwyer, 2007; Salmond et al., 2016; Tyrväinen et al., 2005). These benefits are particularly important in the face of climate change, as cities confront rising temperatures, more frequent heatwaves, and intense rainfall events.

As natural regulators of climate, street trees provide shade and release water vapor through evapotranspiration, helping to cool urban areas and mitigate the urban heat island effect. Their canopies intercept rainfall, reduce surface runoff, and promote infiltration, which is especially valuable in preventing localized flooding. Trees also play a role in carbon sequestration and can contribute indirectly to energy savings by shading buildings and moderating temperature extremes (Nowak & Dwyer, 2007; Salmond et al., 2016; Tyrväinen et al., 2005).

In addition to these environmental functions, street trees significantly enhance public health, well-being, and social cohesion. Exposure to green elements in the public realm has been shown to reduce stress levels, improve cognitive performance, and encourage physical activity and social interaction. Trees enhance the sensory quality of public space, improve walkability, and contribute to safer, more attractive, and more inclusive urban environments (Farinha-Marques et al., 2021; Nowak & Dwyer, 2007).

However, realizing these benefits requires overcoming spatial and functional constraints common to urban streets. As complex linear systems, streets host overlapping flows – pedestrians, vehicles, utilities – that often limit the space available for trees. The success of urban tree planting depends on selecting species that are, not only aesthetically pleasing, but also structurally compatible with streets’ spatial configuration, environmentally resilient, and capable of providing significant ecosystem services over time with minimal conflict.

This paper examines these issues through a case study in Matosinhos and Leça da Palmeira, two coastal parishes in northern Portugal. By analysing the street tree population and street spatial configurations across a heterogeneous urban landscape, the study proposes a framework for enhancing the effectiveness of tree planting in urban streets. Central to the approach is the articulation between tree size, street width, environmental fit, and diversity. The aim is to move beyond ornamental or aesthetic criteria and toward a framework where street trees are seen as spatially integrated, structurally compatible, and ecologically functional components of the urban fabric.

Methodology

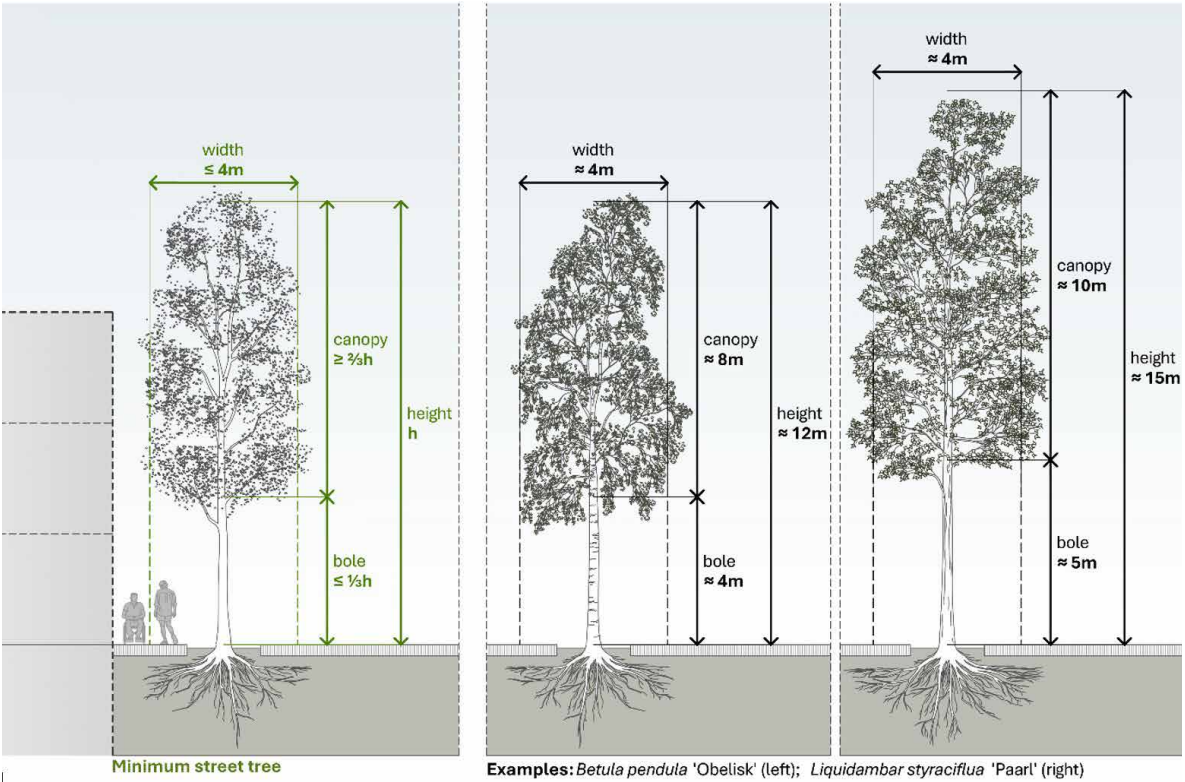
In the context of climate change and increasing urban complexity, understanding the structure, size, and diversity of street tree populations is critical for planning resilient and adapti-

ve urban environments. The capacity of street trees to provide ecosystem services depends heavily on their dimensions and other characteristics. Likewise, the overall resilience of the urban forest is closely tied to its biological diversity and its capacity to withstand environmental stressors, pests, and diseases. Species selection for street planting must also consider a range of site-specific factors, like sun exposure, shade, street orientation, wind or proximity to the sea. However the common factor for discussion should be tree size, as a minimum dimension is fundamental and should apply across all species selected for street planting.

This study adopts the concept of the ‘minimum street tree’ (Figure 1) as a benchmark for assessing the potential of street trees to contribute meaningfully to ecosystem service provision within the spatial and functional constraints of urban streets. The ‘minimum street tree’ is defined, by Farinha-Marques et al., 2021, as the smallest tree that, once mature, can deliver relevant ecological benefits without compromising pedestrian movement and emergency access. For the specific context of Northwestern Portugal, based on the literature and the recent developments of narrow tree varieties in nurseries, the ‘minimum street tree’ is based on the following spatial characteristics:

- Minimum expected height of 12 m (after 20-30 years), capable of forming a clean bole of at least 4 m, to avoid interfering with circulation, and corresponding 8 m canopy (ratio of 1/3 bole to 2/3 canopy) to optimize ecological performance.
- Narrow and/or columnar canopy, with potential growth up to 4 m wide, to reduce competition for space.

Figure 1. Representation of the ‘minimum street tree’ and its spatial features (adapted from Farinha Marques et al., 2021).



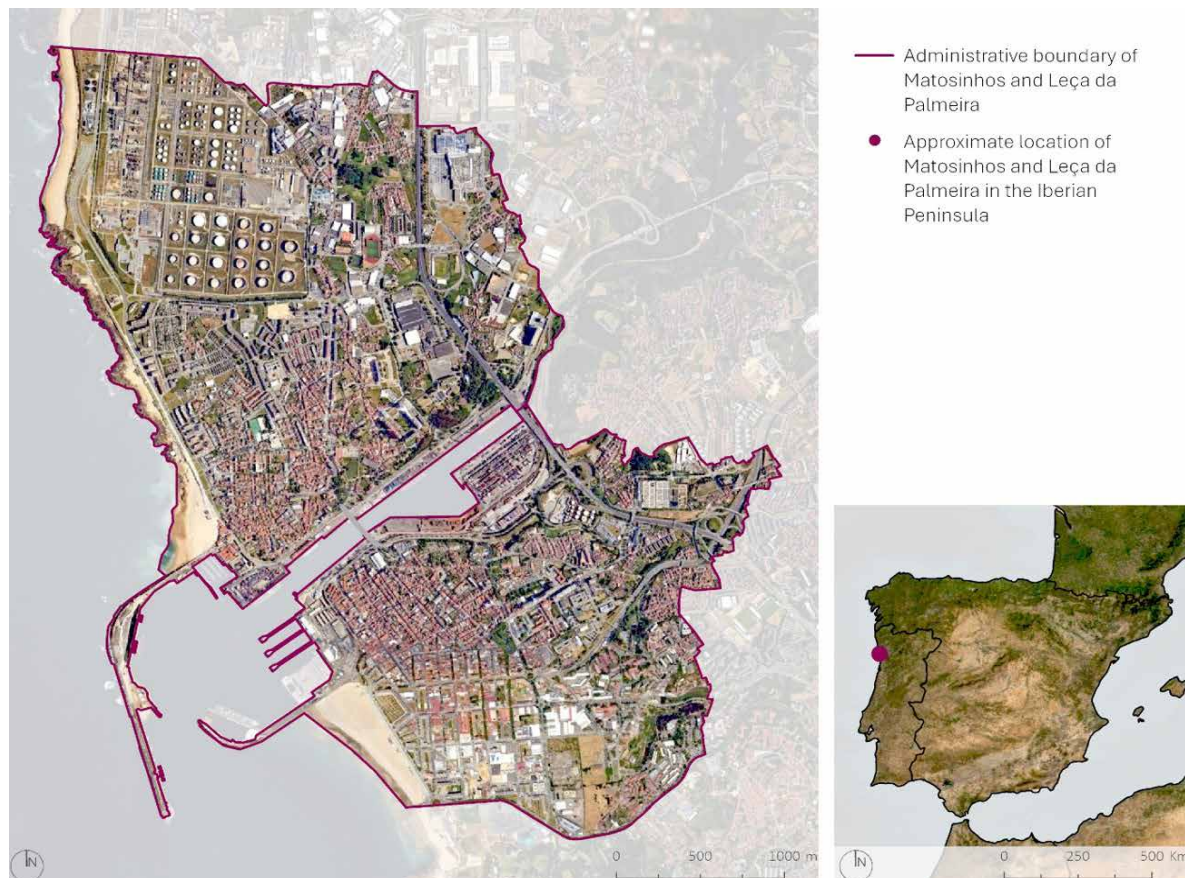


Figure 2. Study area.

This concept provides a pragmatic reference for evaluating existing tree populations and guiding future species selection and planting strategies.

This study is based on the analysis of the municipal street tree inventory (Câmara Municipal de Matosinhos, 2024) of Matosinhos and Leça da Palmeira (Figure 2), which includes 5,813 recorded trees occurring in the public street network (123.9 km). The inventory, provided by the Municipality of Matosinhos, was examined to assess species diversity, species attributes and spatial patterns. The study area exhibits a complex urban fabric, combining historic cores with narrow streets, modern residential zones, industrial areas, and coastal avenues. This diversity makes them a particularly rich context for analysing how different spatial and environmental conditions influence tree selection, performance, and distribution across an urban street network.

Results

According to the most recent municipal inventory, a total of 5,813 trees are planted within the public street network of Matosinhos and Leça da Palmeira. This figure represents 52% of the inventoried urban tree population for the area, indicating the significant role of street trees in the region's urban green infrastructure.

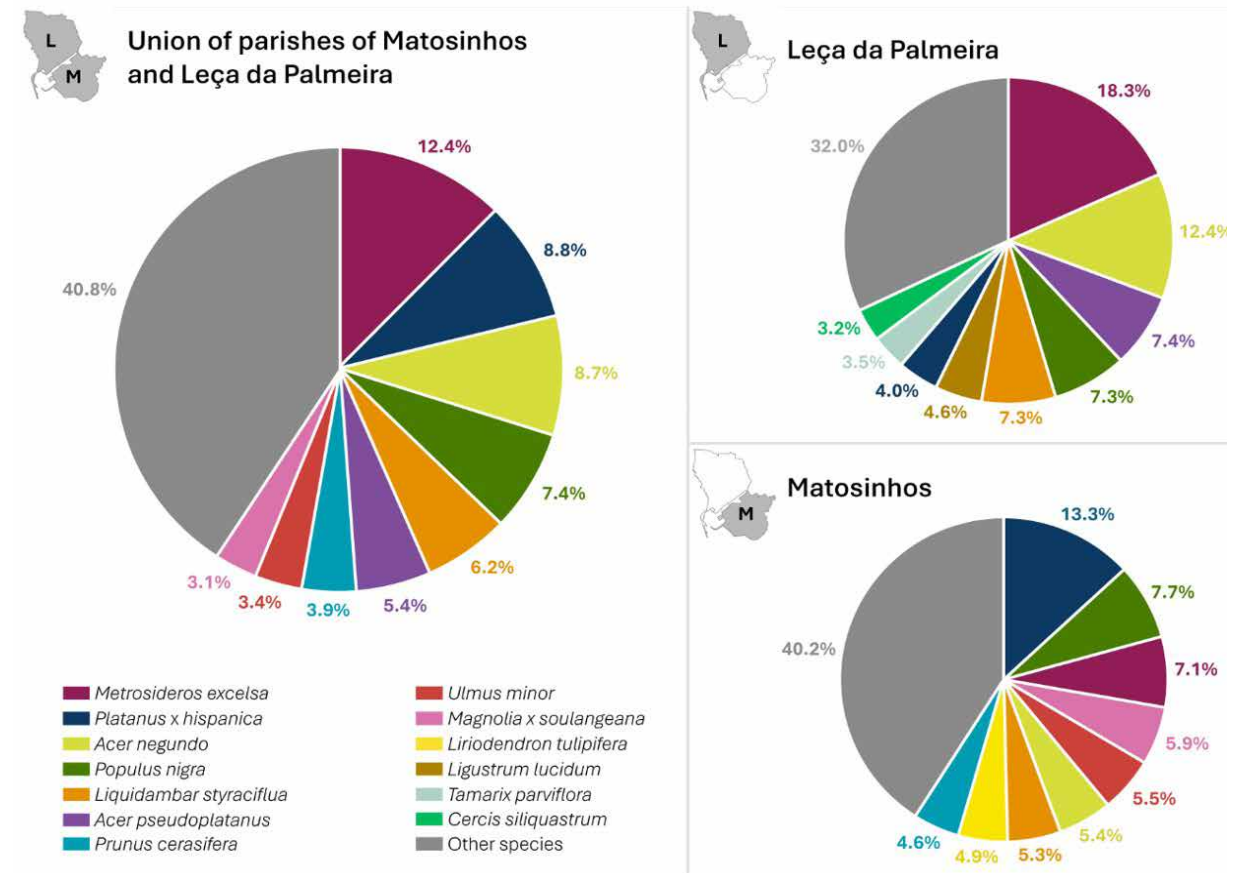
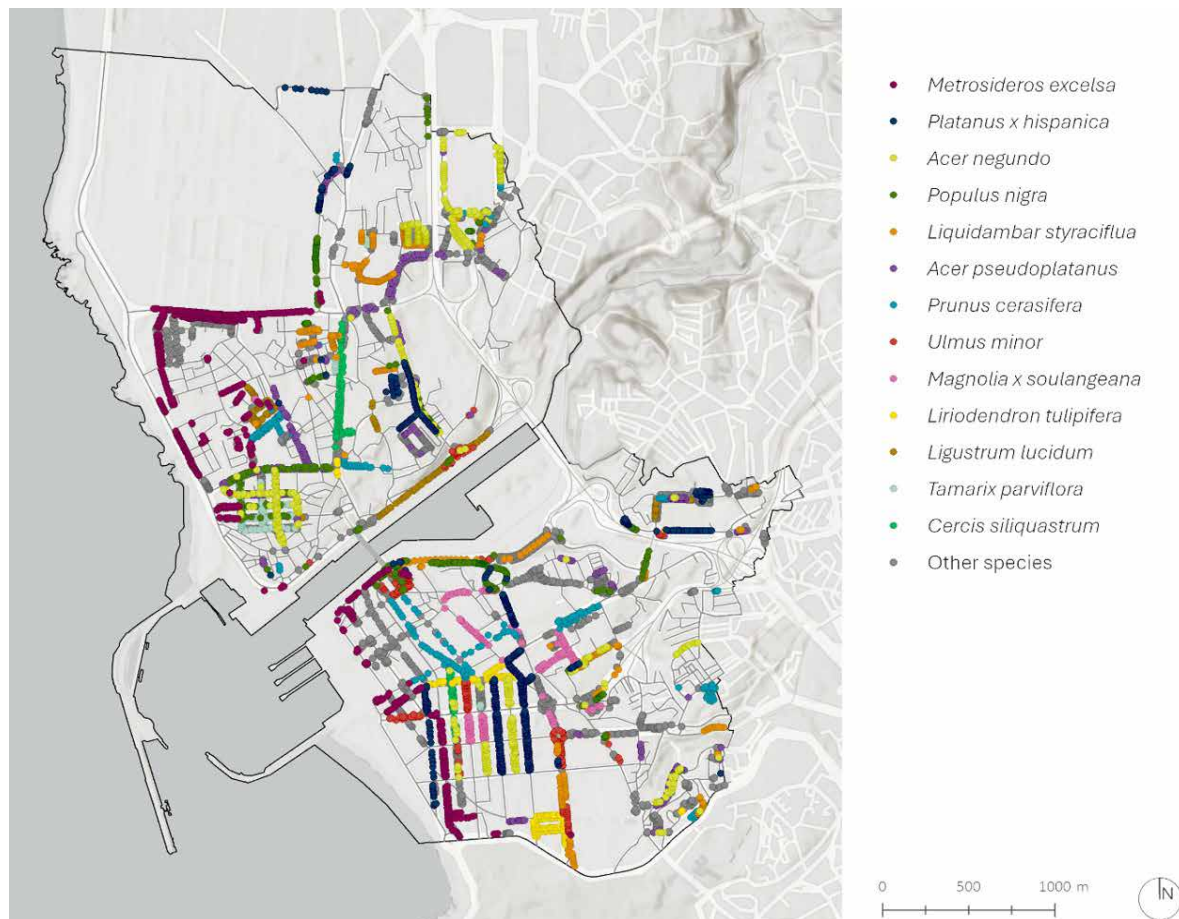


Figure 3. Proportion of species in the street tree population, in the total study area and in each parish.

The street tree population of these two parishes comprises 110 distinct species, spanning 65 genera and 38 botanical families. Among these, a few species dominate the landscape (Figure 3). The most abundant species is the New Zealand Christmas tree (*Metrosideros excelsa*, 719 individuals), followed by the London plane (*Platanus × hispanica*, 513 individuals), the box elder (*Acer negundo*, 504 individuals), the black poplar (*Populus nigra*, 433 individuals), and the sweet gum (*Liquidambar styraciflua*, 360 individuals). Other notable species include the sycamore (*Acer pseudoplatanus*, 312 individuals), the cherry plum (*Prunus cerasifera*, 229 individuals), the field elm (*Ulmus minor*, 195 individuals), and the saucer magnolia (*Magnolia × soulangeana*, 179 individuals).

Regarding their distribution in the different parishes, Matosinhos hosts 3,069 trees across 89 species, demonstrating greater species richness than Leça da Palmeira, which counts 2,744 individuals across 68 species (Figure 3). In Matosinhos, dominant species include the London plane (403), the black poplar (233), the New Zealand Christmas tree (216), and the saucer magnolia (178). Other frequent species in Matosinhos include the field elm, box elder, sweet gum, tulip tree (*Liriodendron tulipifera*), and cherry plum. In Leça da Palmeira, the most numerous species are the New Zealand Christmas tree (503), box elder (340), sycamore (202), black poplar (200), and sweet gum (199). Additionally, species like the Chinese privet (*Ligustrum lucidum*), the small-flowered tamarisk (*Tamarix parviflora*), and



the Judas tree (*Cercis siliquastrum*) appear more frequently in Leça's streets.

Spatial analysis reveals distinct environmental and planning influences on species distribution (Figure 4). Coastal streets (within approximately 500 meters of the shoreline) are characterized by the dominance of the New Zealand Christmas tree (*Metrosideros excelsa*), owing to its high tolerance to wind and salinity. Other species also seem adapted to the coastal influence, including the field elm (*Ulmus minor*) and London plane (*Platanus × hispanica*) in Matosinhos, and the small-flowered tamarisk (*Tamarix parviflora*), spineless yucca (*Yucca elephantipes*), cabbage palm (*Cordyline australis*), Persian lilac (*Melia azedarach*), and black poplar (*Populus nigra*), particularly in Leça da Palmeira.

In contrast, some species are more frequently used in the more interior streets (Figure 4), such as the sweet gum (*Liquidambar styraciflua*), the tulip tree (*Liriodendron tulipifera*), the small-leaved lime (*Tilia cordata*), the silver lime (*Tilia tomentosa*), the Japanese cherry (*Prunus serrulate*), the common beech (*Fagus sylvatica*), the common oak (*Quercus robur*), and the red oak (*Quercus rubra*). Although susceptible to harsh environmental conditions, these larger, deciduous species are often associated with higher levels of ecosystem service provision, due to their canopy size and seasonal dynamics.

Together, these findings suggest a relatively high level of species diversity across the study

Figure 4.
Spatial distribution of the street tree species in the study area.

area, which is promising in terms of ecological resilience. However, the spatial distribution of this diversity is uneven. While some zones feature a broader mix of species, others, particularly in coastal or more recently developed areas, are dominated by just a few taxa. In some cases, these dominant species have spatial and functional features that limit their capacity to deliver the desired ecosystem services. These results underscore the need for more balanced, site-sensitive planting strategies that consider both diversity and functional performance in future planning efforts.

Discussion

The analysis of the street tree population in Matosinhos and Leça da Palmeira highlights both progress and persistent limitations in how urban trees are integrated into the public realm. On the one hand, the relatively high species richness (110 species across 65 genera) suggests a diversified planting strategy with potential for ecological resilience. On the other hand, the structure, size, and spatial distribution of these trees reveal several critical weaknesses that limit their capacity to provide ecosystem services at scale.

In fact, a substantial proportion of the street tree population consists of small-statured ornamental species, such as the cherry plum (*Prunus cerasifera*), saucer magnolia (*Magnolia × soulangeana*) or Judas tree (*Cercis siliquastrum*). While these species may fulfil aesthetic expectations, they typically lack the structural dimensions and canopy volume necessary to provide significant environmental benefits, falling short of the criteria defined for the 'minimum street tree'. Notably, their use is widespread even along streets that offer ample space for larger, more ecologically functional trees. This pattern reveals a disconnect between species selection and the spatial characteristics of the street network, reflecting missed opportunities to maximize ecosystem service provision.

Moreover, while some species choices reflect a commendable alignment with local environmental conditions, particularly the use of the New Zealand Christmas tree (*Metrosideros excelsa*) in coastal areas, greater diversity is still needed. The New Zealand Christmas tree is highly tolerant of wind and salinity, making it an appropriate choice, but its dominance suggests an over-reliance on a single species. Other resilient options, including larger deciduous trees like the London plane (*Platanus × hispanica*) and the field elm (*Ulmus minor*), could offer seasonal benefits and improved microclimatic performance, especially in wider streets. Even in harsh environments, diversity should be pursued to enhance ecological function and reduce vulnerability to pests, diseases, and climate stress.

A further concern is the prevalence of potentially invasive species, such as *Acer negundo* and *Ligustrum lucidum*, which poses risks to local biodiversity and undermines the integrity of urban green networks. Avoiding such species and favouring a varied selection of site-adapted trees is essential to building a resilient and sustainable urban forest.

To address these challenges, we propose the following principles to guide future tree planting strategies:

Use the largest tree possible for the available space. Tree size directly influences the magnitude of ecosystem services provided. Larger trees deliver greater shade, reduce air and surface temperatures more effectively, intercept more rainfall, and sequester more carbon. Therefore, street tree selection should prioritize species capable of reaching meaningful dimensions, at least those of the ‘minimum street tree’, particularly in wide streets and those with central medians, where physical space is not a limiting factor. Tree positioning and underground conditions must be coordinated to support healthy, long-term growth with minimal need for pruning or replacement.

Articulate tree selection and positioning with street width and uses. Street trees must coexist with essential urban functions, including pedestrian flows, emergency access, and multiple infrastructures. However, thoughtful spatial design can accommodate trees even in relatively constrained streets. Good spatial planning allows trees to be included in streets, without compromising accessibility, by placing them thoughtfully in areas where they complement street function and maximize ecological impact. This articulation requires collaborative planning between arborists, street designers, and infrastructure managers.

Match tree species to local environmental conditions. Species selection must consider the specific environmental conditions of each street segment, such as salinity, soil compaction, water availability, heat exposure, and air pollution. For example, salt-tolerant species are essential in coastal areas, while drought-resistant species are critical in unwatered zones. In streets with limited space or strong shading requirements, deciduous species are particularly appropriate, as they allow sunlight to reach façades during winter while providing cooling shade in summer. Matching species to site-specific conditions enhances resilience, reduces maintenance demands, and extends tree lifespans.

Optimize diversity and avoid invasive species. Promoting diversity in the street tree population is essential to ensure long-term resilience against climate variability, pests, and diseases. A varied selection of species, across different genera, growth forms, and ecological functions, enhances the capacity of the urban forest to adapt to changing conditions and reduces the risk of widespread failure. While species choice must always respond to local constraints and environmental conditions, diversity should remain a central goal in any planting strategy. At the same time, the use of invasive or ecologically aggressive species should be avoided, in line with national guidelines and ecological best practices.

Conclusion

This study highlights the critical role that street tree planning and species selection play in shaping resilient, climate-adaptive, and liveable urban environments. In the case of Matosinhos and Leça da Palmeira, the existing street tree population demonstrates encouraging species richness and a clear awareness of environmental constraints in certain areas, particularly along the coast. However, significant gaps remain between the ecological potential of urban trees and their actual performance in the street network.

The widespread use of small-statured ornamental species and the underutilization of larger

trees, particularly where space would allow for them, indicate a missed opportunity to enhance urban ecosystem services. Likewise, a limited selection of species in environmentally challenging areas, coupled with the use of potentially invasive trees, underscores the need for more strategic and ecologically grounded planning practices.

To address these issues, this paper proposes four guiding principles: 1) use the largest tree possible for the available space, 2) articulate species selection with street width and urban functions, 3) match species to site-specific environmental conditions, and 4) optimize diversity while avoiding invasive species. These principles provide a practical framework to support urban forestry decisions and help align tree planting strategies with broader urban design and climate adaptation goals. Municipalities should incorporate these principles at the urban scale, embedding them in street tree planning and overall urban green infrastructure strategies. The spatial allocation for street trees should be planned together with all other street functions and infrastructures, with equal importance, from the earliest stages of street design. This integrated approach ensures that trees are conceived as fundamental components of the street rather than secondary additions.

Moving forward, cities must approach street tree planning not simply as a decorative element but as a central component of sustainable infrastructure. By integrating ecological knowledge with spatial design and long-term management considerations, planners and urban tree managers can work together to build more robust, adaptable, and inclusive green street networks.

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Criteria for defining ‘streets suitable for tree planting’: a model applied to Matosinhos and Leça da Palmeira (Portugal)

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Abstract

Urban tree planting is a key strategy for enhancing environmental resilience, public space quality, and climate change adaptation. Street trees contribute to urban microclimate regulation, air quality improvement, and stormwater management, while also fostering aesthetic and social benefits. However, spatial constraints and competing urban functions often limit opportunities for their systematic integration. Ensuring tree planting aligns with pedestrian accessibility, emergency corridors, and existing infrastructure requires a structured planning approach.

This study presents a model for identifying ‘streets suitable for tree planting’ based on spatial and functional criteria, applied to Matosinhos and Leça da Palmeira (Portugal). The model assesses key parameters such as street width, tree spatial requirements, and compatibility with essential functions, providing a strategic tool for prioritizing street tree planting efforts. This research underscores the necessity of incorporating street trees as a core urban infrastructure, rather than introducing them secondarily after other functions have been accommodated.

A spatial analysis of approximately 124 km of streets revealed that 50% of the street network meets the criteria for structured tree planting, balancing tree placement with pedestrian and emergency vehicle access. Of these, 27.2 km currently lack trees, highlighting significant potential for expanding green infrastructure. Even streets that do not fully meet the model’s criteria may accommodate trees under specific conditions, such as localized widenings, building setbacks, or adjacency to open spaces that create planting opportunities.

While challenges remain, including spatial conflicts and species selection constraints, the model emphasizes the importance of optimizing tree size and location for greater ecological return. Species adapted to local conditions and space-efficient planting strategies are essential in more constrained settings.

By identifying and mapping suitable streets, this approach supports more efficient resource allocation, fosters interdepartmental collaboration, and enhances decision-making. It provides a replicable framework for integrating trees as fundamental components of resilient and sustainable urban environments.

Keywords

Street trees, public space, spatial planning, urban green infrastructure, urban ecosystem.

Introduction

Urban trees are essential components of city infrastructure, offering a wide range of ecosystem services that support human and environmental well-being. The scientific literature (e.g. Nowak & Dwyer, 2007; Salmond et al., 2016; Tyrväinen et al., 2005) shows that: 1) trees contribute to a comfortable urban microclimate by providing shade and releasing moisture through evapotranspiration, thus reducing the heat island effect; 2) they improve air quality by capturing airborne pollutants and producing oxygen, and mitigate stormwater runoff by intercepting precipitation and increasing soil infiltration; 3) they promote biodiversity by providing habitat for wildlife in urban settings, and contribute to urban ecological connectivity; 4) trees enhance mental health and well-being, reduce stress, and encourage social interaction in public space; 5) their presence in streets enhances the aesthetic and experiential qualities of urban environments, and they also promote active mobility by improving walking conditions and offering shade, comfort, and a sense of place. Thus, urban tree planting is a vital strategy for enhancing urban resilience, mitigating climate change impacts, and improving quality of life in cities. However, despite the benefits trees offer in urban environments, spatial constraints and competing urban functions often limit the opportunities for integrating trees systematically into street networks.

A street can be defined as a public linear space within the urban fabric that strongly influences the function, morphology, and character of cities (Farinha-Marques et al., 2021; Lamas, 2000). Streets are multifunctional public spaces that primarily facilitate circulation between different urban areas, providing access to both public and private spaces. Beyond human and vehicular flows, streets also support natural flows such as wind, water, and biodiversity. Infrastructures for essential urban services like drainage, sanitation, and lighting are often embedded within them. Unlike highways or railways, which exclude pedestrian presence, streets maintain a public and multifunctional character (Cowan, 2005; Department for Transport, 2007), making them key areas for social interaction and environmental enhancement.

Streets are typically bounded by private urban spaces, most commonly buildings, and in some cases by adjacent open spaces such as parks, squares, or gardens. Being a linear element, the primary constraint in street multifunctionality is spatial – width becomes a determining factor in whether a street can effectively support tree planting along with essential circulation functions (Farinha-Marques et al., 2021). The successful integration of trees into the urban streetscape requires a careful approach that balances ecological goals with functional street requirements (Farinha-Marques et al., 2022).

To achieve sustainable and impactful urban tree planting, a structured planning approach is necessary. This approach must reconcile the spatial requirements of healthy tree growth with essential street functions. Without such integration, tree planting initiatives may result in conflicts, underperformance, or premature tree loss due to poor site conditions or maintenance challenges. This paper introduces a model for identifying ‘streets suitable for tree planting’, based on the concept of the ‘minimum street tree’ and its inherent spatial needs.

The study explores how the spatial requirements of this ‘minimum street tree,’ when considered alongside essential street functions, determine the minimum street width necessary for effective and sustainable street tree planting.

Methodology

The methodology is based on a functional and spatial analysis of the street environment, focusing on reconciling the three key elements of a tree-lined street: pedestrian circulation, emergency vehicle access, and viable street trees. Therefore, ‘streets suitable for tree planting’ are defined as those that can accommodate systematic and structural tree planting by providing sufficient spatial conditions for the survival of, at least, the ‘minimum street tree’, without compromising the essential circulation functions of the street, namely pedestrian and emergency vehicle circulation (Farinha-Marques et al., 2021).

Streets must guarantee adequate space for pedestrian movement along the edges of the street. We recommend a minimum width of 2 m for each pedestrian corridor to ensure the safe crossing of wheelchairs and/or baby strollers, while also enhancing social life and quality of life on the sidewalk (Department for Transport, 2021). A corridor for the circulation and operation of emergency vehicles should also be safeguarded, with a recommended minimum width of 6 m and clear height of 4 to 5 m (Portaria n.º 135/2020, de 2 de Junho), which guarantees the unobstructed circulation of a large emergency vehicle.

The ‘minimum street tree’ is defined as the smallest tree, at 20-30 years of age, considered viable for providing meaningful ecosystem services in a street environment (Farinha-Marques et al., 2021). For the specific context of Northwestern Portugal, based on the literature and the recent developments of narrow tree varieties in nurseries, the ‘minimum street tree’ is based on the following spatial characteristics:

- Minimum expected height of 12 m (after 20-30 years), capable of forming a clean bole of at least 4 m, to avoid interfering with circulation, and corresponding 8 m canopy (ratio of 1/3 bole to 2/3 canopy) to optimize ecological performance.
- Narrow and/or columnar canopy, with potential growth up to 4 m wide, to reduce competition for space.

To maximize the viability of the tree, several spatial requirements should be considered, regarding its establishment in the street. We recommend that the dimension and positioning of the tree ensures a minimum distance from the canopy to building façades or property lines of, at least, 1 m, to minimize pruning and other maintenance operations, which will have positive impacts on tree survival and on budget allocation. Likewise, we recommend that the trees are planted in permeable strips or tree pits with at least 2 m, for the ‘minimum street tree’, to enhance soil volume and improve root health.

The minimum street width for ‘streets suitable for tree planting’, here determined as 10 m, was calculated by considering the spatial needs of the ‘minimum street tree’ in conjunction with the essential circulation functions of the street, as illustrated in Figure 1. Streets narro-

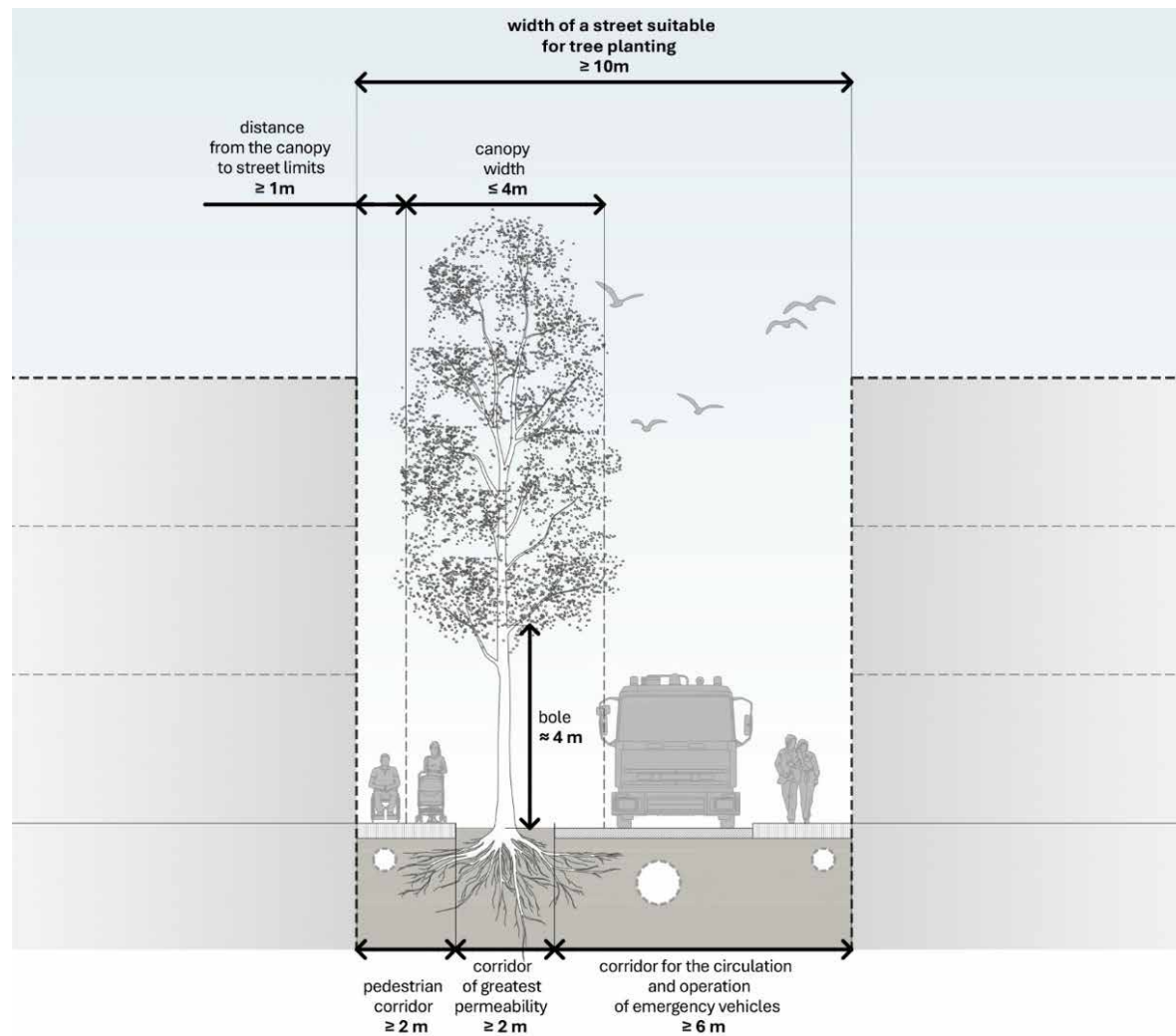


Figure 1. Representation of the minimum street suitable for tree planting.

wer than 10 m are classified as ‘not suitable for tree planting’ under the systematic and structural approach of this study due to conflicts between these essential functions and the presence of the ‘minimum street tree’.

This approach guided the analysis of the study area of Matosinhos and Leça da Palmeira, in Portugal, regarding the suitability of its streets to accommodate trees. These civil parishes are located in the Municipality of Matosinhos, a coastal city in Northern Portugal, where the proximity of the Atlantic Ocean highly influences its predominantly mediterranean temperate climate (Figure 2).

Using the cartographic databases provided by the Municipality of Matosinhos, the width was measured for 124 km of streets, in a GIS environment. Main roads, highways and rail ways were not considered in this study, due to their exclusion of pedestrian traffic; tunnels, viaducts and bridges have also not been included, due to their restrictions for the occurrence of trees.

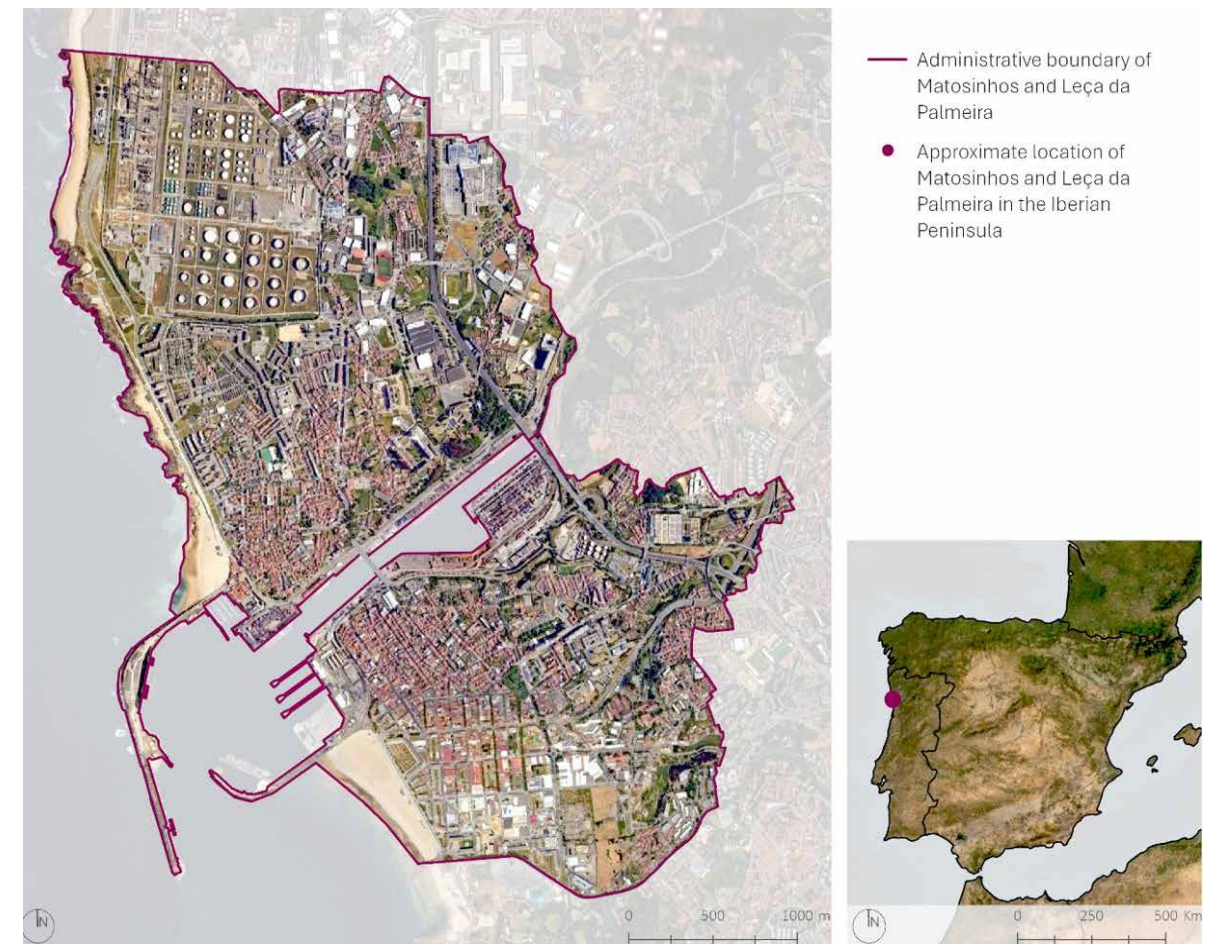


Figure 2. Study area.

Results

This approach identified 62.3 km of ‘streets suitable for tree planting’, which is equivalent to around half of the existing streets (Figure 3). In these streets, it is possible to make the presence of street trees compatible with the existence of an emergency corridor suitable for large rescue vehicles, and a pedestrian corridor accessible to people with reduced mobility, without compromising either function.

In 33.4 km, corresponding to 26.9% of the streets in the study area (Figure 3), it will not be possible to articulate street tree planting in a systematic and structural way, while complying with the minimum dimensions previously stipulated for these three elements (street tree, emergency corridor and pedestrian corridor). However, in these streets that were considered as ‘not suitable for tree planting’, the presence of trees may be allowed in exceptional cases, subject to a detailed analysis of the conditions of each site. Examples of such exceptional situations include facade setbacks, localized street widenings or intersections with other streets that increase the available width and allow for tree planting without compromising accessibility or circulation.

Streets associated with public open spaces (28.2 km, 22.8% of the streets; Figure 3) are

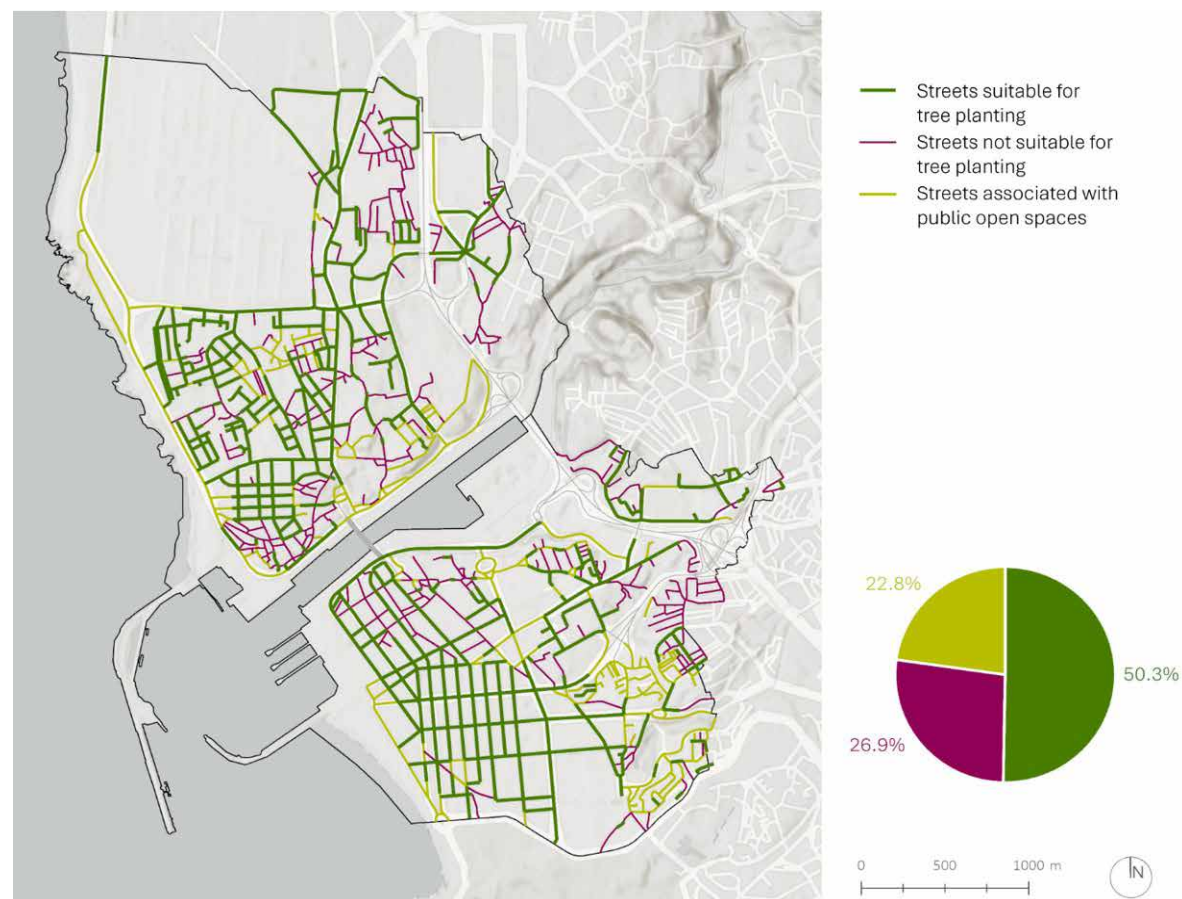


Figure 3. Streets suitable for tree planting.

excluded from this approach, since the opportunity introduced by the presence of the open space, as well as the possible presence of trees in the open space, will influence the space available for street tree planting. In these particular cases, tree planting on the street, as well as in the open space, will have to be planned case-by-case in order to be optimally adapted to the specific characteristics of each site.

Focusing only on the 'streets suitable for tree planting', around 35.1 km are already occupied by trees (Figure 4). This means that approximately 27.2 km of streets still offer the opportunity for systematic tree planting in Matosinhos and Leça da Palmeira (Figure 4). This significant potential underscores the value of a structured approach to maximize green infrastructure.

Discussion

The identification and mapping of 'streets suitable for tree planting' offer a strategic advantage for urban planning in Matosinhos and Leça da Palmeira. By assessing street width across the network, the municipality can prioritize interventions in areas with the highest potential for successful tree establishment and ecosystem service provision. This targeted approach enhances the efficiency of resource allocation and project implementation.

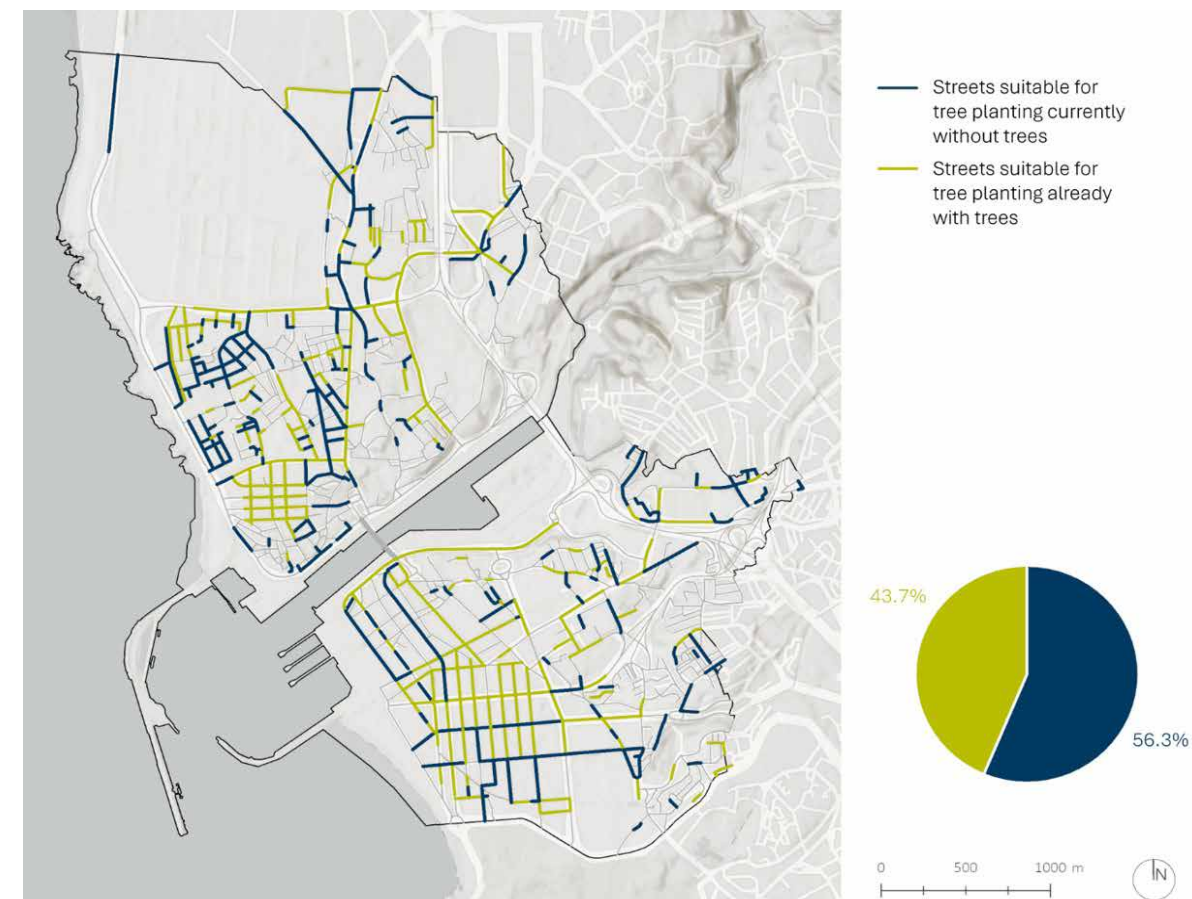


Figure 4. Streets suitable for tree planting, according to the current existence of trees.

The concept of the 'minimum street tree' provides a practical foundation for establishing spatial guidelines that balance biological viability with urban functionality. By specifying minimum canopy and bole dimensions, the model helps avoid the frequent mistake of planting undersized trees that fail to deliver meaningful ecosystem services. Moreover, the explicit correlation between street width and tree size highlights the importance of maximizing tree dimensions within the available space, as larger trees tend to offer significantly greater ecological and social benefits.

The 10 m threshold reflects the fundamental spatial trade-offs inherent in street design. The allocation of space for pedestrian corridors and emergency vehicle access directly impacts the available space for tree planting. It also reflects the importance of proactively planning for trees as infrastructural elements rather than retrofitting them into leftover spaces.

Nonetheless, it is crucial to acknowledge that urban conditions are highly variable. In certain scenarios, even streets narrower than 10 m may accommodate trees through design adaptations. Localized street widening or building setbacks can enable tree planting in constrained environments. This flexibility is essential in historical areas or dense urban fabrics where street dimensions are very limited. The presence of adjacent open spaces also introduces opportunities to extend tree canopy coverage beyond the street itself. Where public gardens, squares, or corridors are present, tree planting strategies should be integrated across the

broader public realm to maximize ecological and social benefits.

Species selection is another critical factor, as street trees must adapt to local conditions. For example, in Matosinhos and Leça da Palmeira, species must be resilient to coastal winds, high humidity, and occasional salinity. Choosing resilient trees that are tolerant to pollution and capable of thriving in compacted soils is crucial for the long-term success of planting initiatives in streets. Narrow or columnar species are particularly valuable in space-constrained streets, where lateral canopy spread must be limited.

Moreover, spatial planning must consider the lifecycle of the tree. Tree pits and root zones must be designed to accommodate growth over decades. Soil volume, permeability, and access to water and nutrients are essential for healthy root development and canopy growth. In this regard, coordinated efforts between urban planners, arborists, landscape architects, and civil engineers are key.

The spatialization of results facilitates communication and collaboration among professionals from different disciplines. Visualizing which streets are suitable for tree planting helps identify patterns, constraints, and opportunities, supporting more informed decision-making. This contributes to the integration of green infrastructure into broader urban planning efforts, reinforcing the importance of cross-sectoral coordination in developing resilient and liveable cities.

Conclusion

This study presents a spatial model for identifying streets suitable for tree planting, grounded in the concept of the ‘minimum street tree’ and the functional requirements of the urban street. The model establishes a 10-meter minimum width threshold for structured, long-term street tree integration, providing a valuable framework for urban planners and decision-makers.

The application of this model to the study area of Matosinhos and Leça da Palmeira demonstrates its practical relevance. With approximately 50% of the local street network deemed suitable for tree planting, significant opportunities exist to enhance green infrastructure, improve urban liveability, and increase climate resilience.

Ultimately, this research contributes to a broader understanding of how to integrate trees as fundamental elements of urban infrastructure. By aligning ecological goals with spatial realities, the approach supports the creation of healthier, more sustainable, and more liveable cities.

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MOBILITY

Streets, as spaces that accommodate different mobility modes and systems, are constantly transforming, dealing with a wide range of small and large technological innovations. The intensity of uses generates imbalances and injustices that are addressed daily through ongoing corrective efforts. The five articles associated with this thematic dimension explore processes of reconversion of car-centred infrastructures, promoting active and soft mobility, and recognising the importance of well-designed ground floors, with a focus on the level of pedestrians.

The contributions emphasise active mobility, cycling, and, above all, pedestrian comfort. They remind us that cities are diverse and that transforming the street into an inclusive space requires attention to the specific needs of different user groups, as well as openness to design solutions that respond to those specificities. In this context, digital tools emerge as an opportunity to enhance listening and participation processes, giving voice to users and pursuing greater equity.

Finally, the focus returns to the physical space and to the role of the ground floor in relation to pedestrian movements. This highlights that street spaces influence walking routes beyond dedicated pedestrian areas, which also include spaces within buildings and other parts of the public realm itself.

Along the banks of Via de Cintura Interna: A 5-step strategy for transforming an expressway into an urban avenue

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Abstract

Porto's Via de Cintura Interna (VCI) is an urban inner ring road that acts as a barrier for people and biodiversity, jeopardising decarbonisation goals. The road's urban and environmental impact also radiates beyond its edges, increasing the 'VCI effect'. A five-step strategy to transform the VCI into an urban avenue aims to enhance quality of life and ecosystem functions, overcoming the primacy of cars and recovering pedestrian space. The construction of expressways and the popularisation of automobiles brought about broad lifestyle changes, the organisation of urban space and mobility patterns. Over the last 60 years, highways have shaped the urban landscape, paradoxically contributing to both the integration and fragmentation of territories. Nowadays, urgent intervention in these infrastructures is needed to reverse the devastating environmental, social and urban effects of 'rodoviarism'.

This proposal highlights the potential of the VCI and its edges to integrate urban ecosystems, environmental support and the urban fabric. Therefore, this approach repositions the road as a catalyst for mobilising social and ecological components, promoting healthier lifestyles and a livable habitat. Beyond mobility, this urban intervention addresses: intra- and peri-urban dynamics, community diversity, ecology and memory.

This paper, an outcome of a research project developed in the Integrated Master's Degree in Architecture at the Faculty of Architecture of the University of Porto, presents intervention strategies and practices for the urban insertion of highways, adopting the ring-road express Via de Cintura Interna do Porto (VCI) as a case study. The proposed five-step strategy offers a plausible vision for restoring urban quality and street life, taking environmental decarbonisation goals as the motor for urban rehabilitation centred on sustainable mobility. It is also intended to share critical reflections from this theoretical exercise and some possible paths for intervention on large-scale road infrastructures, in search of a potentially more porous, inclusive, and resilient territory.

Keywords

Via de Cintura Interna do Porto, road infrastructure transformation, fragmented city, urban regeneration, sustainability



Why expressways?

The rise of expressways, driven by automobile popularisation, profoundly reshaped lifestyles, urban space, and transportation. Private cars redefined spatial boundaries and destinations, bringing mobility autonomy and leading to a “subjective construction of the territory” (Rémy, J., 2007, as cited in: Portas et al, 2011). These changes have drastically altered the logic and image of cities, complexifying notions of road hierarchy, centrality, density, and especially distance (Dupuy, G., 1995). Over the past 60 years, modernist, function-driven urbanism (Asher, F., 1998) — guided by planners and market forces (Hall, P., 1996) — has positioned highways as key elements of urban form (Oliveira, V. et al., 2015), paradoxically serving as agents of connection and territorial fragmentation.

Nowadays, intervention in these infrastructures is urgently needed to improve land use, contain urban sprawl and reverse the devastating environmental, social and urban effects associated with ‘rodoviarism’. Environmental agreements demand a shift towards carbon-neutrality, prompting initiatives to regenerate motorways and reclaim the pacification of public spaces through active mobility. This work seeks to learn from them and contribute to solutions tailored to ‘fragmentation, discontinuity and heterogeneity’ (Calix, T., 2013) in the territory under study.

Methodological approach

The methodological framework behind this proposal includes a study of the evolution of the problem, types of solutions and best practices for the urban integration of expressways. In connection with the conception and implementation of the VCI, Porto’s historical urbanisation process analyses rely mainly on bibliographic, cartographic and iconographic research, planning instruments, as local development plans and municipal master plans (respectively, ‘Plano Regulador’ and ‘Plano Diretor Municipal’- PDM, according to the designation in Portuguese). Regarding cartography, the research was particularly supported by Vitor Oliveira works (Oliveira, V., 2013).

The analysis of VCI’s impact on urban morphology was based on observation of the territory using three narrative devices: Structure, Texture and Context, which allow us to “identify the distinctive characteristics of each ‘autonomous’ and recognisable fraction of the urban environment” (Calix, T., 2013, p. 499), making them intelligible so that we can then intervene in them. The characterisation of the VCI and its margins considered four themes - biophysical and environmental support, urban fabrics, urban qualities and dynamics, and mobility and flows - to cover the different dimensions of the current situation for prospective analysis.

The analytical process followed a fragmented approach, examining the whole through its parts, to reveal the points of rupture and distinctions of character associated with the road, its margins, or both. The analysis highlighted how the surrounding area is affected by the relations with centralities and by local mobility. It also re-vealed different problems and conflicts related to pedestrian and soft mobility, which proved instrumental in establishing design rules and solutions. Systematising these problems can also provide a key to understanding similar cases from a methodological point of view.

Via de Cintura Interna (VCI): A study case in Porto

The ring road typology is found in many contexts and is common in cities which grew from a central core. With car saturation and suburbanisation, ring roads, junctions and radial arteries divert passing traffic, connecting peripheral cities and providing access to the traditional centre (Bell, J., 2001).

Envisioned in 1954 as a Green Belt Avenue surrounding the densely urbanised area of Porto’s city, the urban ring road was committed to the new Arrábida Bridge, ending at a second road-rail bridge to the east, thus establishing two new connections over the Douro River (Garret, A., 1952). However, the ‘Avenida de Cintura’, as it was then called, was already included in the 1945 National Road Plan, and formed part of the main north-south transport route and radial roads associated with junction points.

Construction of the VCI began in 1963 following urban expansion and the displacement of the population to social housing on the rural outskirts (Oliveira, J., 1973). The 21km ring, surrounding the centre core of the cities of Porto and Vila Nova de Gaia, linked by



Arrábida and Freixo Bridges, was gradually executed in sections, being concluded in 2007 (Figure 1.1). Thus, the VCI (or IC23) combines several mobility infrastructures, connected through 12 road links. It plays a dual role (Figure 1.2) acting as a collector and distributor for the national road network while providing local connections to the surrounding urban fabric (Leite, 2016). By then, the design choices managed nationally by Infraestruturas de Portugal S.A. no longer aligned with Porto's evolving needs (Oliveira, V. et al., 2015). The subversion of its original design and the increasing volume of car and freight traffic have shaped its current profile, disrupting the urban fabric and dividing neighbourhoods (Oliveira, V., 2013). The Outer Ring Road of Porto (CREP, also known as A41) was built in 2011 to divert through traffic and lighten the load of heavy vehicles on the VCI (Figure 1.3).

Although Porto's City Council promoted studies for VCI's urban integration (Faria, N., 2004), aiming to transform it into an urban avenue (Lusa, 2011), the requirement to reduce its monofunctional mobility role postponed the idea. The current PDM emphasises multi-modal policies (Câmara Municipal do Porto, 2019), as traffic pollution jeopardises the 2030 decarbonisation goals. It also proposes a third ring road (CRIP), intermediate between VCI and CREP, to redirect traffic via a new bridge. According to the PDM, the urban regeneration of the VCI depends on three key conditions: a revision of the CREP toll regime (Moreira, R., 2020) - already underway - the closure of the CRIP as a traffic buffer, and a successful modal shift within the Porto Metropolitan Area (CM do Porto, 2019).

Day-to-day life on the VCI and its margins

Currently, the VCI handles around 130,000 vehicles/day and is regularly cited for its congestion, pollution and traffic accidents (Figure 2.1). This infrastructure disrupts the urban environment, harming people's health and well-being. Its mono-functionality excludes

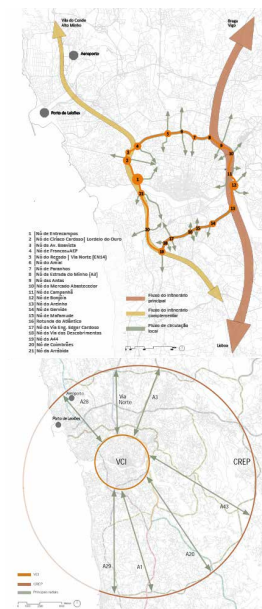


Figure 1.1. Scheme of Porto's Via da Cintura Interna: Surrounding the city centres of Porto and Vila Nova de Gaia; **Figure 1.2.** Traffic flows in territorial context (yellow and red) and intra-urban flows (green); **Figure 1.3.** concentric scheme of Porto's metropolitan area, showing the outer ring road (CREP).



Figure 2.1. Satellite view of Porto, showing the study area (right); **Figure 2.2.** View of VCI taken by Amial's social housing street. **Figure 2.3.** View of VCI taken by a pedestrian overpass in Paranhos; **Figure 2.4.** Satellite view of the VCI's road interchange Regado /Via Norte;



public transport, cyclists and pedestrians.

Environmental and urban degradation extends to its surrounding areas, amplifying its negative impact. Declining land values have led to the construction of housing blocks that are exposed to constant noise and pollution (Figure 2.2). Beyond contributing to global warming and biodiversity loss, the VCI also imposes costs on the healthcare system.

The VCI forms varying relationships with the topography, with sections in trenches, elevated segments, and occasionally at ground level. The dissociation between the road's construction logic and the territory's morphology reinforces the sense of rupture, splitting the city in two and creating barriers that limit pedestrian crossings (Figure 2.3). The road's imposition as a new order over the existing one exposes, in the urban fabric itself, the gap between the original idea and its execution (Coelho, C., 2018). Cutting the street network fosters autonomous logics and dead-end streets, reinforcing circulation issues and eroding the urban fabric (Portas, N. et al., 2011). Access points and junctions occupy extensive areas, wasting urban space (Figure 2.4).

While the two-way motorway - with three traffic lanes, plus service and acceleration lanes, ranging from 25 to 34 metres wide - features extensive devices for cars, people must rely on a few footbridges and tunnels. Into this context, imagining the VCI as a boulevard—with bike lanes, footpaths, and gathering spaces—may seem utopian. Yet accessibility means autonomy, it represents the right to the city (Lefebvre, H., 1968), as a place of diversity and sharing. The VCI is a piece of infrastructure belonging to the public realm. These kinds of structures, to which all citizens have the right of access and use, are therefore considered a shared collective asset. (NeHo, O., 2018).

This theoretical strategy plan, developed in the Integrated Master's Degree in Architecture at the Faculty of Architecture of the University of Porto, explores the potential of the VCI and

its edges to recompose the city’s form and complexity (Piroddi, E., Colarossi, P., 1991). Driven by sustainable mobility, decarbonisation is the engine of this urban regeneration, aiming for a more cohesive, inclusive, and resilient territory for all life forms. In five steps, this proposal seeks to restore urban quality and street life, overcoming car dominance and recovering pedestrian space.

How can we bring people closer to the VCI?

As high speeds and parking demand consume valuable public space, reclaiming it for people is crucial. Given the urgency in promoting sustainable cities, redefining the road’s role at both local and territorial levels is essential —shifting policies and transitioning from individual car use to sustainable mobility alternatives. At the territorial scale, this requires declassifying the VCI as a national freeway and adjusting vehicle speed and flow. Using the outer ring roads as a traffic buffer, the VCI can function as an intermediate inter-municipal network, catalysing urbanity, boosting and diversifying node accessibility. At the urban scale, integration with the surroundings and articulation between margins depend on rebalancing use and space, coordinating modes and speeds (Portas, N. et al., 2011), and offering individual-scale options (Asher, F., 2010). Sustainable mobility and inclusive meeting places foster community, enhance physical and mental health (Gehl, J., 2014), and reinforce commitment to the climate pact.

A central goal is to integrate natural and urban systems, and the VCI plays a role in building a more cohesive, inclusive and sustainable urban network. The strategy focuses on: valuing the natural structure; regenerating the fragmented urban fabric by reconnecting pre-existing paths; assigning new functionalities to the VCI; enhancing accessibility; and providing quality space for new housing and facilities. Introducing new functions and travel modes, including public transport, aims to ensure equitable access to public space and mobility through a democratic and diversified vision of urban space (Gehl, J., 2014).

The surrounding natural structures, as watercourses and green corridors, support sustainable mobility and public spaces network (Portas, N. et al., 2007), while the continuity of existing paths enable the densification of the fabric, reconnect neighbourhood and link old and new centralities, to ‘control the coherence of the whole and the internal connection of the fabric’ (Piroddi, E., Colarossi, P., 1991). Transforming the road’s character and removing interchanges frees up land for new building areas, designed in analogy with the existing urban fabric. Proposed collective housing, public services, and commerce form small neighbourhood units, enhance cultural and urban spaces, enabling new flows. The mix of uses ensures daily urban activity, with pedestrian mobility prioritised.

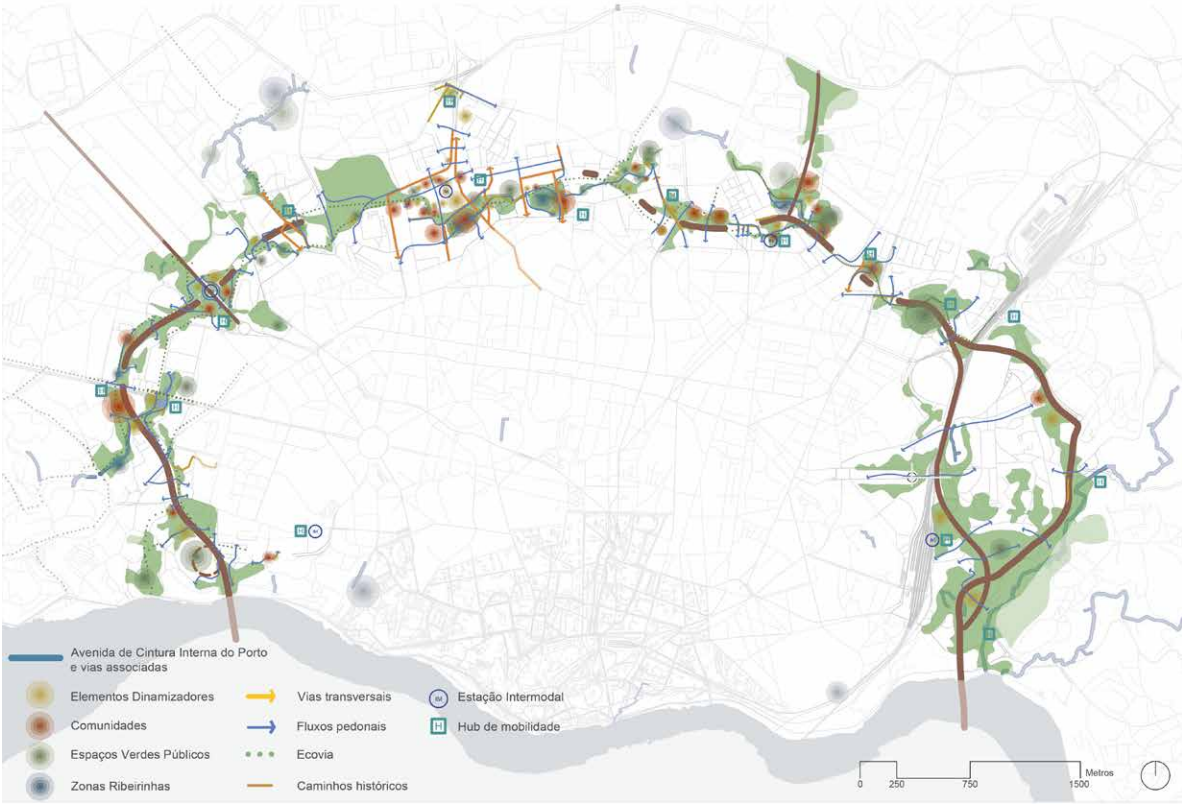
The strategy (Figure 3), operating across macro, meso and micro scales, is phased over a long-term process that points to a 50-year horizon, due to its territorial scope, high cost, complexity of the actions and actors involved and the need for continuous monitoring, considering also the multiple societal challenges associated with the automobile. However,

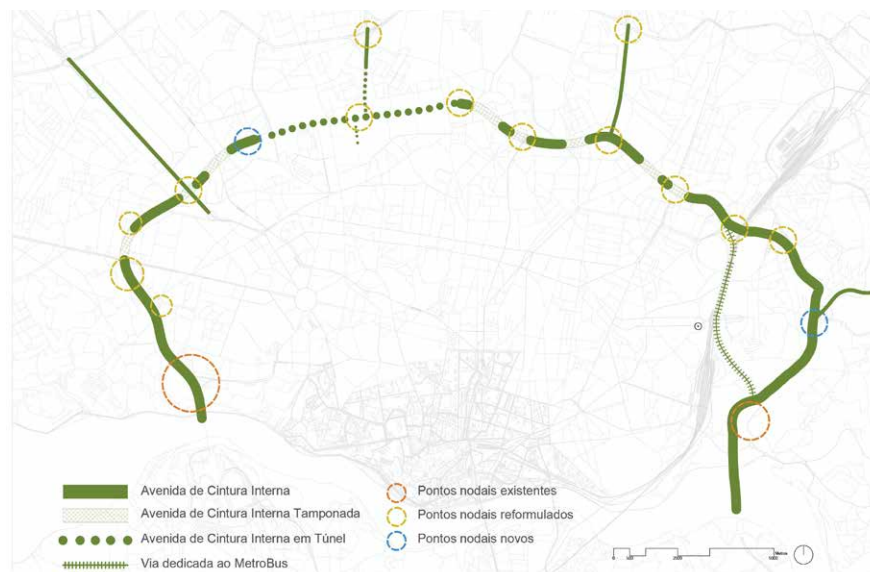
achieving the environmental goals of Agenda 2030 requires immediate actions with short-, medium- and long-term impact. The process, which is flexible and long-term, must allow for adaptations, setbacks and advances, but in such a way that each step in itself - systematised into a thematic axis - can represent added value for people’s well-being. Therefore, the duration of each phase is an illustrative suggestion, emphasising the sequence of strategic actions themselves. The two lines of action focus on the VCI itself and, most importantly, on its margins; increasing public service and urbanity with small and tactical interventions can gradually bring people closer to the VCI, reducing the intensity of its impact. The measurement of its success is instrumental for larger-scale implementation.

Solutions are tailored to each segment’s relationship with topography and context: where in level with its edges, the VCI becomes an urban avenue; in the trench sections, a buffer is introduced; in the most urban stretch connected to Via Norte, it is tunnelled (Figure 4.1). This approach allows autonomous local crossings and restores pre-existing connections. Given the VCI’s territorial role and interchanges, the stages of the intervention involving the creation of tunnels and the demolition of viaducts and ring roads were subject to a macro phasing (Figure 4.2) with a sequence associated with the redistribution of traffic flows (Figures 4.3 and 4.4).

The implementation strategy is crucial to ensuring the viability of this proposal and should be a continuously evolving process. Its proposed phasing is therefore open and inviting to the use of funding opportunities. Upon transfer to municipal administration, the bottom-up

Figure 3. Strategy synthesis and the exclusive route reserved for intermodal services near Campanhã Station.





participatory process should involve parish councils, residents' associations, other stakeholders, technicians, academics, and be open to public-private partnerships. Funding may come from various sources, but Infraestruturas de Portugal S.A. participation must be included as compensation for the environmental and urban impacts caused by the VCI.

Alignment with the Sustainable Development Goals (SDG) allows access to various projects, including European investments, while the project's scope supports applications for funding from parish councils, crowdfunding, and other channels. As an open and long-term initiative, implementation should be overseen by an external commission comprising public and civil representatives.

A 5-step strategy for transforming an expressway into an urban avenue

Step 1: Decarbonization 2030 (2026-2028): Focused on reducing CO2 emissions through immediate low-cost measures, the goals include slowing traffic and promoting public and active mobility. Taking advantage on ongoing or approved mobility projects (Metro, BRT, CREP), restrictions will be placed on truck circulation and size with freight distribution subject to timetables. Noise and air pollution are reduced by policies to discourage car use, such as vehicle rotation and tax incentives for carpooling. The speed reduction to 50 km/h increases connectivity, frees up side lanes for trees and allows testing an Eletrobus service on the ring road. Bus stops will be linked to pedestrian crossings, street networks and mobility hubs, offering a range of active mobility, shared and public transport options. As strategic high-accessibility points for commuter flows, the interchanges will allow car parking. Road pacification and greening will foster behavioural change, progressively bringing people closer to the VCI.

Step 2: From neighbourhoods to communities (2028-2032): The improved environmen-



Figure 4.1. (left) Road structure proposal;

Figure 4.2. Schemes of the phasing strategy: Three phases of intervention on VCI's infrastructure;

Figure 4.3. Concentric scheme indicating the new intermediate ring road CRIP.

Figure 4.4. traffic flows in territorial context with the CRIP buffer;

tal quality enables medium-cost investments on urbanity and liveability. Removing acoustic barriers marks the first stage of transforming the VCI into an avenue, starting on the stretches where it sits at grade with surrounding buildings. The new profile gathers public transport, cycle lanes and sidewalks, with tree-lined green beds to mediate different speeds and allow water infiltration. The extension of cul-de-sacs will create new connections with the street network. Pedestrian crossings with traffic lights will be introduced near schools, supermarkets and along the Via Norte. Existing underpasses will be activated with public gatherings promoted by local communities and street art. Creating the new Regado Park will drive the intervention along the VCI's inner margin, opening up two large blocks to the city, dynamized by new housing, commerce and amenities. New active urban frontages will find, in private initiative, the financial subsidy for the creation of the public park. A green-blue corridor will reconnect ecosystems and integrate buildings' green spaces, leftover spaces and inner plots, driving the VCI gradual change from highway to an urban avenue. The connection of green pores will create an ecological and diverse mobility network (Secchi, B., Viganó, P., 2005).

Step 3: Public space for all (2032-2040): Promoting public spaces and collective equipment is essential for a safer, equitable and permeable city. To bridge the trench-divided margins of the VCI, this step invests in high-cost solutions with buffers covering stretches in the trench, providing public green space, while improving noise, local air quality and climate comfort. Connections with the pre-existing street network will be restored, interrupted paths between old neighbourhoods will be recovered, and the urban fabric will be stitched based on logics familiar to the territory (Figure 5). Acting on the SDGs opens access to European funds, and empowers communities to seek support through crowdfunding and other funding sources. Pedestrian access between the lower and upper levels of the VCI will ensure accessibility for high-capacity public transport, whose demand should have been tested, monitored and evaluated in the previous stages.

Step 4: Cities in movement (2040-2044): The previous steps increased the integration of the VCI into the urban fabric and strengthened the inhabitants' relationship with nature and the territory. The modal transition supports the demand for high-capacity public transport with Porto-Gaia MetroBus running on the central reservation. Synchronised traffic lights near the MetroBus intermodal stations will reinforce vertical and horizontal connections between the margins. These medium-cost measures will enhance accessibility and connections between transport modes at short and long distances. Transport stations, assumed as places (Teles, P., 2019), can foster the local economy, promoting thriving communities and improving social realm. The high-capacity transport may also connect the entire Porto Metropolitan Area.

Step 5: Living the street (2044-2063): The final step will remove intrusive infrastructures such as interchanges and overpasses. At this point, the concrete life-cycle has already reached its limit, justifying demolition over costly maintenance. Technological advances will allow more efficient, lower-impact execution. Priority will be given to the most urban and disruptive section, between Francos and the A3 junction, which includes demolishing

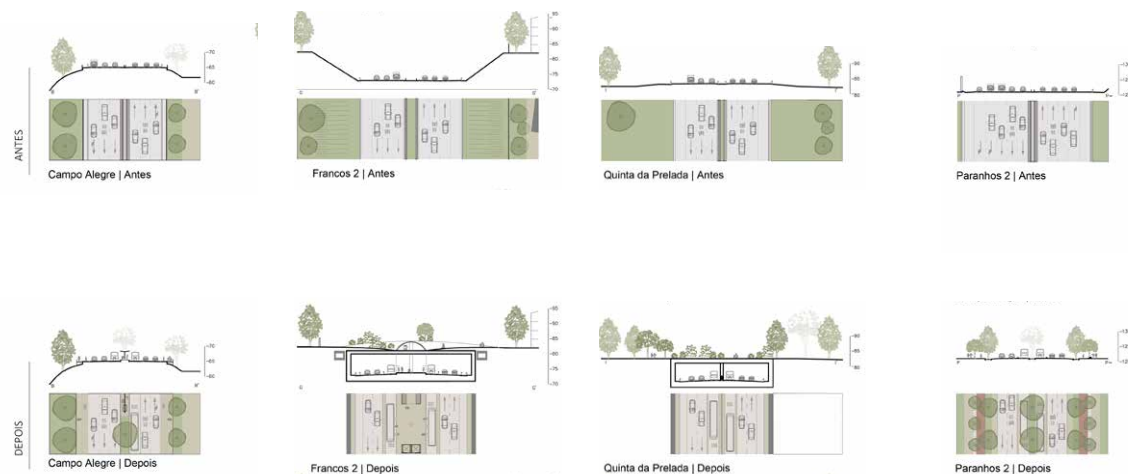


Figure 5. Transforming the VCI, from highway into an avenue. Cross-section profiles: Before (top) and after (bottom).

the tunnel and road links. Removing the tunnel enables the creation of extensive public space, new connecting roads and cultural facilities. Restoring the unity of Quinta da Prelada enhances the area's natural and historical heritage. The high-cost investment must count on national subsidy in return for the social and environmental damage caused by the VCI. Works will then proceed along the Arrábida and Freixo axes. Redesigning key local nodal points (Ciriaco Cardoso/Boavista and Antas) as gyratory blocks can drive the intervention by attracting new development. The new buildings, set within reclaimed land, recognise “the textile dimension of the territory” (Calix, T., 2013), regenerating the urban fabric in line with pre-existing texture.

Replacing multi-level interchanges with roundabouts optimises space and improves safety for pedestrians and cyclists (Figure 6). The MetroBus line and the Intermodal Stations become fully operational at the AEP, Via Norte and A3 junctions. Their connectivity gives the area the capacity to bring people from far and wide (Gehl, J., Gemzile, L., 2002).

The transformation of the road into an avenue will allow for the implementation of a ‘green heart’, connecting the urban and environmental network. The proposal envisions a barrier-free city, more isotropic and resilient; a habitat in tune with nature’s rhythms.

Guidelines for the future: What have we learned?

Sixty years passed between the original idea of the Via de Cintura Interna and its closure with the Freixo Bridge. Reversing this into an urban avenue will take decades, involving complex actions and actors. It must confront the “multiple societal challenges, rich in problems, conflicts and contradictions associated with the automobile” (Asher, F., 2010, p. 138).

The intervention must balance flexibility—for funding timelines—with firmness regarding



Figure 6. The proposal and the transformed interchanges. The resolution of the interchanges of Ciriaco Cardoso, Paranhos and Antas was based on the reconstruction of the pre-existing connections between the two banks of the VCI.

essential values: health, safety, sustainability, and social equity. The planning process must engage local authorities, technicians, and, above all, the community. As Helena Roseta (2024) highlights, the emergent process encourages learning from the people on whose behalf we have to design, building with them the objectives to be achieved, the resources to be mobilised and the shared decisions to be made.

Strategic-collaborative public policies and ongoing monitoring are essential to ensure residents/businesses permanence, and that actions stay aligned with the collective agenda and local aspirations. The phased strategy remains open to funding opportunities. While public-private partnerships are welcome, private interests must not dictate the programme or use of assets intended for collective benefit (Asher, F., 2010).

The theoretical exercise developed in this research aims to propose possible solutions and their applicability to the context of Porto through strategic actions linked to thematic axes. The implementation strategy is, therefore, a key element in ensuring the viability of this “utopia”, since each action represents immediate added value, creating consistent conditions for the next step. The aim is to create a virtuous cycle where improvements foster a sense of common good, healthier and more participatory practices, stronger societal engagement, and a positive impact on the targeted areas.

Given the recurrence of the ring road typology and the associated implementation mode, testing tactical solutions, which are more geared towards political will than costly infrastructure interventions, can unlock the transformation of the character of these motorways in different contexts.

The guiding principles of the proposal can be applied to various contexts, as they are aimed at enhancing biodiversity and integrating the natural structure into the system of collective spaces, linking green spaces and green corridors to public transport, cycle and pedestrian

networks. The regeneration of the urban fabric based on old footpaths and small spaces “in between” improves the network of minor roads, making the urban network more porous and diversifying traffic flows. By assigning new functions to the VCI and removing road interchanges, the aim is to better use land for housing, collective facilities and dynamic hubs.

Reducing car traffic and speed, adding pervious surfaces and water retention, increasing green areas and human engagement with nature and the historic identity of the place, and encouraging active mobility have a direct impact on improving environmental and ecological conditions, heat effect, physical and mental health, social interactions and community engagement (Wu, Y. et al, 2025; Konijnendijk, C., 2021; Nieuwenhuijsen, M.J. et al, 2022; Nieuwenhuijsen, M.J. et al, 2024; Ajuntament de Valencia, 2022; Hassen, N. & Kaufman, P., 2016).

The aim is to offer equitable access to the “city”, a more permeable environment that allows mobility for people, water, vegetation, and animals, contributing to a more isotropic and resilient territory.

Ultimately, this research project aimed to expose part of the complexity of urban mobility and glimpse a plausible path of transformation based on ecological viability and sustainable mobility, grounding solutions that reflect the values and concerns on the production of common spaces for collective well-being.

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Contribution to the inclusion of a gender perspective in bicycle mobility policies: The case of the Lisbon Metropolitan Area (Portugal)

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Abstract

The gender gap in cycling is explained by several factors, such as cultural, the lack of adequate infrastructure or women's mobility patterns. Little attention has been paid to gender issues related to urban mobility. In this work, we tried to understand how public policies can promote an increase in women using bicycles, with the focus in the Lisbon Metropolitan Area (LMA). Through cyclist counts, a survey of mobility agents and document analysis of equality and mobility policies, it was set recommendations to apply to mobility policies.

Of 515 cyclists observed in 6 locations in LMA, only 13.6% were women. It was found some lack of articulation between equality and mobility policies. Of the 17 municipal plans for equality evaluated (2013-2023), only 1/3 include measures for urbanism and mobility – training, mapping areas needing improvements such as public lighting. These good-example policies are recent and were developed with the know-how of entities that work on gender equality. From the analysis of 13 mobility policies (2005-2021), it was concluded that the majority do not include a gender perspective, with only 3 directly addressing gender issues. Even so, some of the measures in the field of bicycle mobility, safety, and school mobility would be favorable for more women to use bicycles.

From the analysis of the survey carried out among mobility agents, it was found that there is a gap between the perceived knowledge and reality when it comes to issues of gender and mobility. Environmental issues were considered more important than gender equality, as stimuli for implementing measures pro-cycling.

The key factors to have more women cycling seem to be the inclusion of a gender perspective in mobility policies, stakeholders involvement and implementation of inclusive urban infrastructures. This requires the development of new models of collaboration and participation, innovative, inclusive, and transparent.

Keywords

Gender, women, mobility, bicycle, public policies

1. Introduction

1.1. Relevance of the theme

Cycling in urban areas is quite challenging in Portugal, facing the lowest bicycle usage and the highest cyclist accident rates in Europe. Safety -traffic-related or personal, objective or perceived -negatively affects the adoption of active mobility (Shaer et al., 2023).

Statistics reveal that cycling accounts for 0.58% of trips across the country and 0.53% in the Lisbon Metropolitan Area (LMA) (Instituto Nacional de Estatística, 2022). Women represented 26% of cyclists in Lisbon in 2020, highlighting a gender gap (Câmara Municipal de Lisboa, 2021). The case study in this article focuses on the LMA, the main urban concentration in Portugal, and intends to contribute to more gender-disaggregated data in bicycle mobility in new portuguese cities, to conducte an innovative comparative analysis of public policies, and to apply a questionnaire to gather perceptions regarding the integration of gender issues in mobility planning.

1.2. Research question and objectives

This study seeks to answer the research question: How can public policies promote an increase of women using bicycles for urban mobility? To answer this question, the study proposes four objectives:

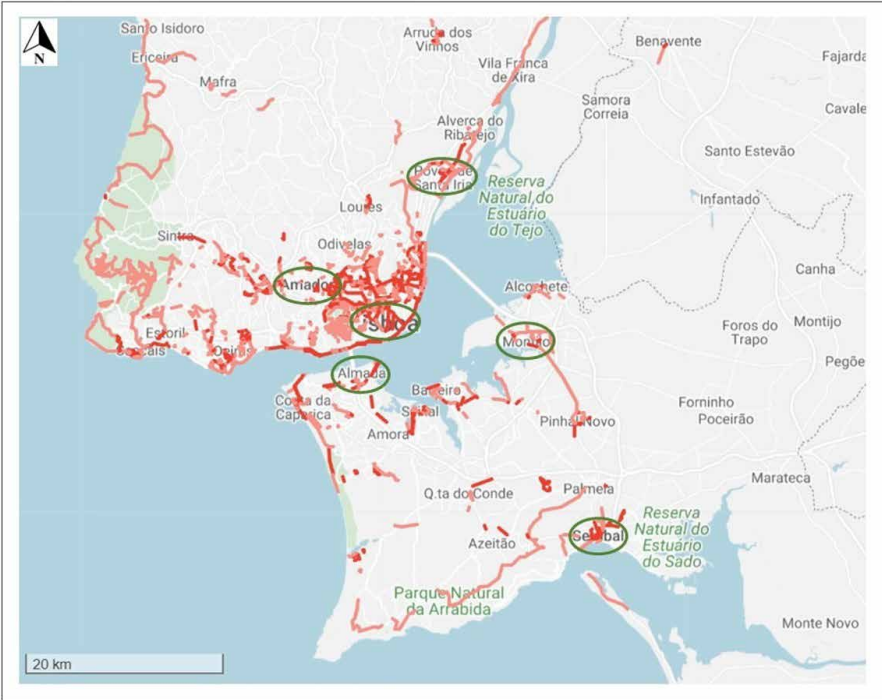
1. To assess the extent of gender gap in bicycle use within the LMA;
2. To analyze how mobility strategies and gender equality plans are integrated;
3. To identify mobility experts' perceptions regarding strategies to promote cycling, including among women;
4. To contribute to the design of mobility public policies that promote gender integration in cycling.

1.3. Methodology

This research is based on a methodology involving field observations, document analysis and surveys, culminating in recommendations for more gender-inclusive mobility policies.

Field observations were conducted between April 13 and 20, 2023, through direct observation in six LMA municipalities: Almada, Amadora, Lisboa, Montijo, Setúbal and Vila Franca de Xira. Data were collected during three weekday peak periods, near bike lanes or proximity to transport hubs, based on the tools ciclovias.pt and Strava Heatmap (fig.1). The method adapted Moura et al. (2020) records of cyclist flow to collect apparent sex (woman/man) inferred by appearance. Some limitations of this approach are that it does not capture self-identified gender, and not all cyclists could be counted, particularly some wearing helmets for whom apparent sex could not be determined.

Figure 1. Map of bicycle lanes in the LMA, indicating municipalities where cyclist counts were conducted. Source: ciclovias.pt, 2023.



Document analysis of equality and mobility policies in the LMA was conducted, aiming to identify connections between both, using indicators from the “Gender Audit Checklist in the Transport System” (Lopes et al., 2016). Among the eighteen LMA municipalities, seventeen had gender equality policies, published between 2013 and 2023. It was examined aspects such as objectives, targets, involvement of external entities and measures related to urbanism and mobility, calculating mention indexes. Regarding mobility, 13 policies, published between 2005 and 2021, of different territorial levels (municipal/intermunicipal/metropolitan) and modes of mobility were analyzed. It was evaluated equality, safety, school mobility and bicycle promotion, through indexes calculated from the frequency of terms, allowing an assessment of the attention. A limitation of this analysis is that it was conducted by a single author, without a double-check or inter-coder reliability assessment, so the results may reflect subjective interpretations.

A **survey** was applied to mobility agents, inspired by Alm & Koglin (2022), to gather perceptions on bicycle mobility and gender. The survey, available on Google Forms from 4 to 29 April, 2023, covered areas such as individual perceptions about bicycle use, including differences between men and women and importance of promotional and inclusive measures. A total of 113 people responded, considered 101 valid responses - the mobility agents – with professional experience in mobility or in bicycle mobility. For logistical and technical reasons, it was not possible to conduct the survey to a pre-defined, representative sample. Nonetheless, the survey was conducted with broad dissemination to the target audience via email, LinkedIn, and in-person actions. The results therefore carry the inherent limitations of a convenience sample.

2. State of the art

Bicycle mobility policies are becoming increasingly popular worldwide to enhance safety, foster healthier communities and address climate change. Nonetheless, incorporating gender issues into these policies has received limited attention. Literature review shows that men and women have distinct mobility behaviors, because of factors such as caregiving responsibilities, perceptions of safety (personal, infrastructure, urban environment), or economic resources. These patterns are linked to gendered societal roles, where women undertake a larger share of unpaid work, such as domestic tasks, care for children and the elderly (Gamrani & Tribouillard, 2021; Heffernan et al., 2021; Pourhashem et al., 2022; Queirós et al., 2019), impacting their mobility options and access to urban opportunities.

Women represent only 20% of leadership positions in European transport sector (European Institute for Gender Equality, 2016; Ramboll, 2021) and public policies and urban planning have historically ignored gender-specific needs, favoring longer-distance home-to-work trips, usually made by men (Parnell et al., 2023). Due to need to chain multiple trips related to different purposes, women value flexibility over time-efficiency. However, due to less economic capacity than men, women have lower access to private and more efficient modes of transport, spending more time travelling, further penalizing them (Singh, 2020). Also, women have a greater environmental awareness, preferring more sustainable mobility (Pires Rosa et al., 2016). This lead to women using public transport and walking more, while men more using private vehicles (Ramboll, 2021; Pires Rosa et al., 2016; Pourhashem et al., 2022; Souza et al., 2018).

Safety concerns, particularly harassment and violence in public spaces and mobility, strongly influence women’s travel choices, routes or clothing (Heffernan et al., 2021; Homem De Gouveia et al., 2020; Souza et al., 2018; Tiznado-Aitken et al., 2024), beginning in adolescence (Sayagh & Dusong, 2022), and also impacting in urban cycling (Cubells et al., 2023).

Historical and cultural factors also tend to discourage women from cycling (Sayagh & Dusong, 2022). As a result, a gender gap in bicycle mobility persists in many countries and cities, especially where are low-cycling rates (Parnell et al., 2023; Ravensbergen et al., 2023). Evidence from countries with greater gender equality in cycling, such as Denmark or the Netherlands, show that when specific barriers are removed, urban cycling can become a more equitable way of transportation (Battiston et al., 2023), so understanding the barriers and motivators to women is essential for planning inclusive cities (Pearson et al., 2023).

Addressing the gendered differences and considering inclusion in public space planning is crucial for reducing social inequalities (Gehl Institute, 2018) or to prevent their reinforcement, that persist in other societal spheres, and may lead to social exclusion (Tiznado-Aitken et al., 2024). This integration in planning process is crucial not only for environmental goals but also for gender equality (Arenas, 2022; Lopes et al., 2016; Queirós et al., 2019).



Figure 2. Photographs of cyclist observations in Almada and Setúbal. Source: authors' own photographs.

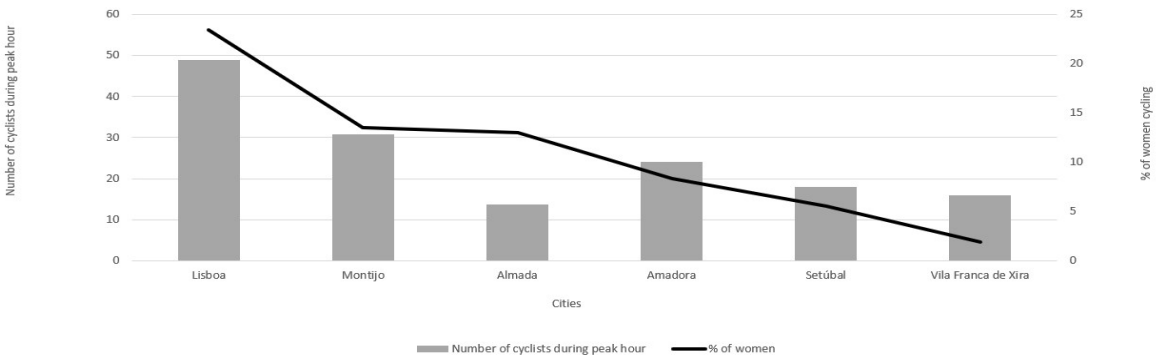


Figure 3. Proportion of women cycling relative to cyclist flow. Source: authors' elaboration.

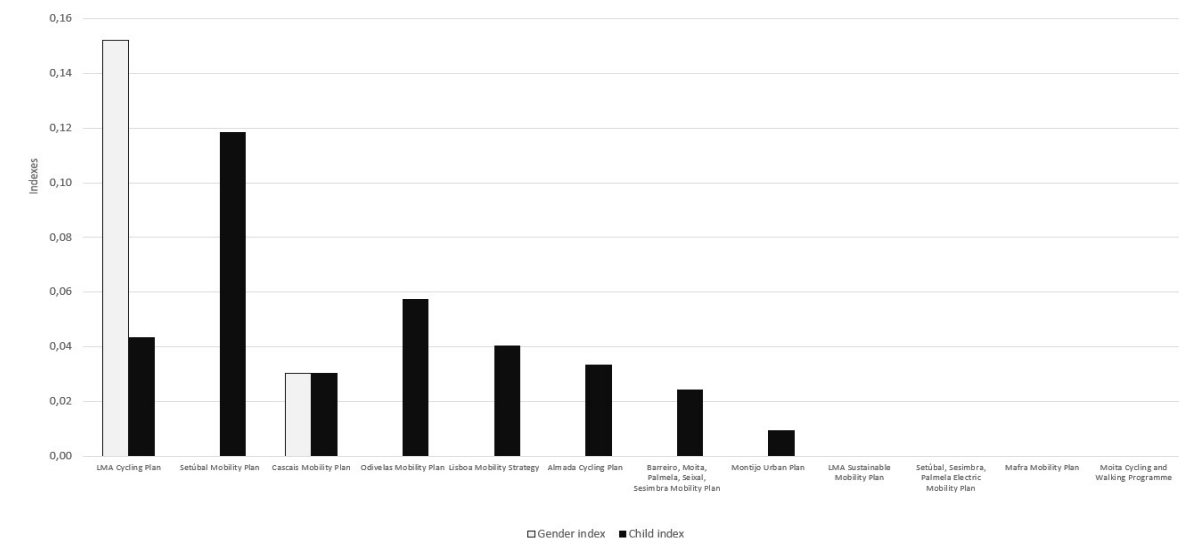
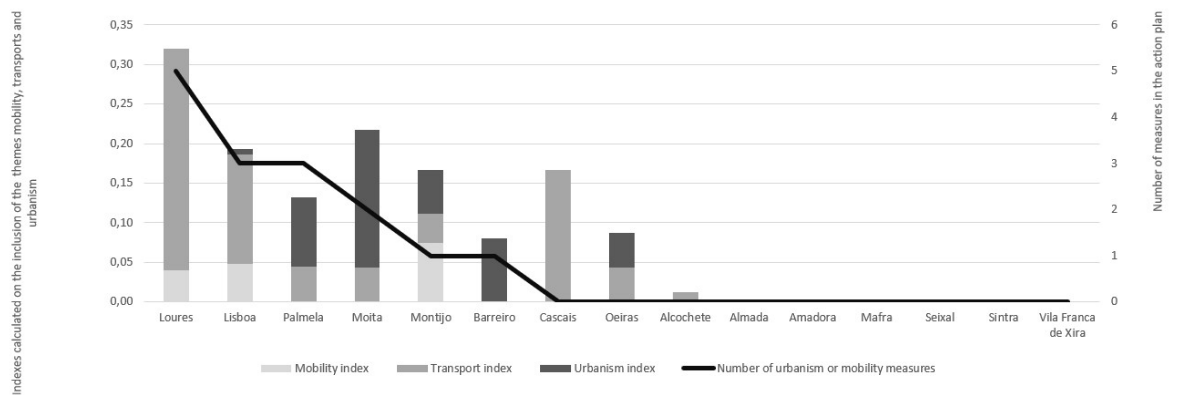
3. Results and discussion

3.1. Gender inequality in bicycle use in Lisbon Metropolitan Area

From 21 hours of field observations, 515 bicycles were counted, with women representing 14% of the users, confirming the gender gap in this way of transportation.

Significant differences in the proportion of women cycling were noted depending on the locations: Lisbon had the highest proportion (19%), followed by Almada (17%), Montijo (13%), Setúbal (11%), Amadora (5%), and Vila Franca de Xira (2%) (fig.2).

The proportion of women cycling is an indicator of safety for cycling (Heffernan et al., 2021; Ramboll, 2021; Sustrans, 2018), so it can be concluded that, among the locations analyzed, Lisbon appears the safest (fig.3), possibly reflecting investments such as bike lanes, speed limit streets, public bike-sharing system and financial incentives. Gender differences in cycling mobility tend to be more pronounced in cities with lower cycling rates (Sustrans, 2018), as seems to be the case in the LMA. Thus, safer streets for cyclists contribute to more inclusive cities.



3.2. (Dis)articulation between equality and mobility policies

The document analysis revealed that seventeen from eighteen municipalities in the LMA have gender equality policies, but only six include urbanism and/or mobility measures in the action plans, mainly training, awareness or diagnosing to improve infrastructure.

The municipality of Loures has an equality plan with the highest proportion of inclusion in mobility, transport, and urbanism, followed by the municipalities of Lisboa, Palmela, Moita, Montijo, and Barreiro (fig.4). These six plans are recent, published after 2019, and either created in collaboration or include measures intended to be implemented by external entities.

Regarding mobility policies, despite the metropolitan plan for sustainable urban mobility, one-third of the municipalities lack local plans. Overall, LMA mobility plans do not incorporate a gender perspective. An initial indication is the absence of sex-disaggregated data, with only three of the thirteen mobility policies analyzed including, mainly at the diagnose phase. Analysis of “gender” and “child” indexes show greater importance given to age than gender (fig.5).

Figure 4. Inclusion of urbanism and mobility dimensions in the equality plans of the Lisbon Metropolitan Area municipalities. Source: authors’ elaboration.

Figure 5. Importance given to women and children in mobility policies of the Lisbon Metropolitan Area. Source: authors’ elaboration.

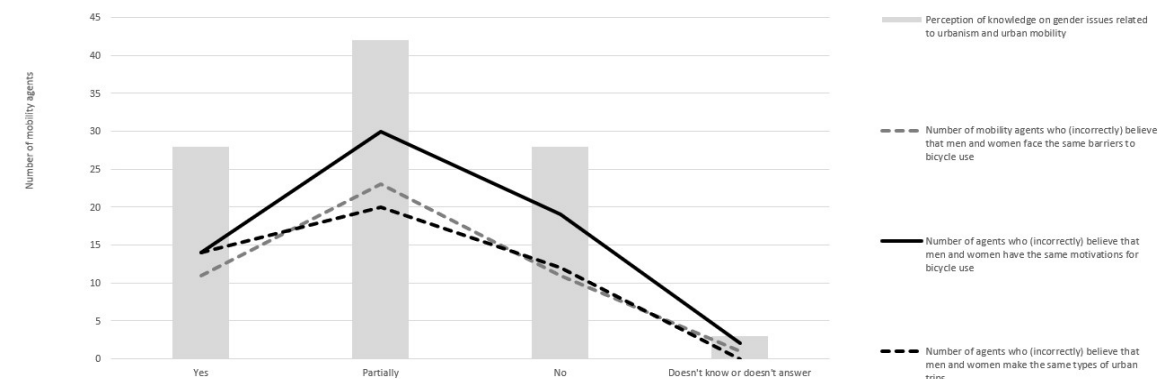


Figure 6. Gap between perceived and actual knowledge of gender issues in mobility by the mobility agents. Source: authors’ elaboration.

If implemented, many plans contain measures that could support increasing bicycle use among women, particularly regarding cycling mobility, safety, and school mobility, such as expanding cycling network, introducing urban design to reduce motor traffic speeds, or promoting group cycling-to-school programs.

The analysis also indicated that, although most equality policies foresee staff training on gender issues, specifically targeting urban planning and transport decision-makers, this information is unlikely to reach those who draft the mobility plans, mostly external consultancies or mobility research centres.

These results highlight the need for mobility assessments based on urban context and socio-demographic diversity, in order to develop mobility policies that address the needs of the entire population. The measures implemented directly impact the everyday experience of public space and streets (safety, convenience and comfort).

3.3. The need for greater training of mobility agents on gender issues

The analysis of 101 valid survey responses characterises “mobility agents”: between 25 and 63 years old, 62% aged 45 or older, 55% identified as male and 43% as female. Half work in municipalities, 18% in mobility agencies, 10% in private companies, 7% in national transportation entities and 7% in regional. About 61% reported involvement in bicycle mobility planning or implementation, 61% use a bicycle at least once a month, more than one-third do not use it. Key findings:

- 52% perceive that men and women face different barriers to cycling;
- 47% recognize differences in trips made by men and women, more women agents;
- 30% believe that men and women may have different motivations for cycling;
- Gap between perceived and actual knowledge of gender issues in mobility (fig.6);
- Over half believe (lack of) political will as the main obstacle to implement cycling measures;
- 43% believe decision-makers have expertise in bicycle mobility;

- 63% view the climate neutrality 2050 goals as the main stimulus for promoting cycling, gender equality as lowest priority;
- Most believe that the mobility decision-making with the community is only partial.

These results highlight the need for greater training on gender and mobility issues, targeting staff and decision-makers.

4. Policy recommendations for enhancing women's bicycle mobility

4.1. Integrating gender perspective in mobility policies

Mobility isn't gender-neutral. Women's needs, uses, experiences, and perceptions differ from men's, and infrastructures, solutions and services impact people differently, leading to disparities in transports. Thus, mobility policies should incorporate a gender perspective at all stages—diagnosis, design, implementation and evaluation.

Institutions responsible for transport and mobility could include experts with knowledge of gender and mobility. Staff should be trained in gender-related issues, including those in customer service, technology development and new services (Heffernan et al., 2021), communication, urban planning, mobility, and accessibility (Lopes et al., 2016; Queirós et al., 2019).

Gender-disaggregated data must be collected regularly on trip characteristics - duration, time of the day, season, frequency, reasons (work, school, family care, shopping, services, leisure,...), modes of transport, origin and destination and safety perceptions - to inform measures addressing women's needs (Arenas, 2022; Lam, 2022; Lopes et al., 2016; Queirós et al., 2019).

4.2. Stakeholder engagement

Women's involvement is essential in urban and mobility planning. It's recommended that authorities adopt participatory methods, ensuring transparency and engaging civil society (Arenas, 2022; Heffernan et al., 2021; Lopes et al., 2016), specially women, fostering democracy (UN-Habitat, 2022).

Gender equality should be a shared goal in policies, and engagement with gender-focused entities is necessary for aligning strategies. Gender-sensitive mobility improvement studies should use diverse methodologies, such as stakeholder consultations and focus groups, to understand daily realities and needs (Lopes et al., 2016). Gender and mobility working groups would enable collaboration, enhancing gender integration in mobility policies.

4.3. Inclusive urban and cycling infrastructures

Inclusive infrastructures are critical to promoting women's cycling (Arenas, 2022;

Copenhagenize France, 2020; DIAMOND, 2022; Gamrani & Tribouillard, 2021; Ravensbergen et al., 2023; Yadav & Kumari, 2024):

- Cycling infrastructure prioritizing safety to minimize conflicts between pedestrians/ cyclists/vehicles, with segregated bike lanes on main roads, quality intersections and reduced vehicle traffic speeds;
- Transport interfaces as central urban hubs, facilitating intermodality (bicycle/public transport);
- Resting points and public restrooms, particularly near transport hubs;
- Active facades and good visibility;
- Secure bike parking facilities, available at origin and destination;
- Public bicycle-sharing systems, including baskets or child seats, to support domestic and caregiving tasks;
- Well-lit public spaces, including walking and bicycle paths;
- Design promoting universal accessibility, namely to people with reduced mobility, ensuring adequate width, pavement quality and maintenance.

5. Conclusion

This study discusses gender inclusion in cycling mobility policies, aiming to reduce the gender gap and promote its integration in public policies. The research question led to the following conclusions, organised around four objectives.

First, field observations across six municipalities in Lisbon Metropolitan Area revealed that only 13.6% of the 515 cyclists were women, highlighting gender imbalance.

Second, analysis of LMA equality and mobility policies show that only one-third of seventeen equality plans address mobility. These are recent, developed in collaboration with gender experts. Only three of thirteen mobility policies mention gender, revealing a lack of gender sensitivity. It was also found that it is given more importance to age than to gender. Some measures could benefit women to cycle, related to safety, cycling and school mobility.

Third, the survey to mobility agents revealed a gap between perceived and actual knowledge regarding gender and cycling. Gender equality was lowest priorities for promoting cycling, while carbon neutrality goals were on top. (Lack of) political will was seen as the main barrier to implementing cycling measures.

Fourth, recommendations highlights a gender perspective into mobility policies, fostering stakeholder collaboration and participation, and implementing inclusive infrastructure. This requires new, innovative, and transparent governance models.

Future research could establish a "gender and mobility working group", ensure representative survey, and expand teams dedicated to urban policy and cycling analysis across the LMA (enlarging the sample size, diversifying case studies, and extending periods of cyclist counts).

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Walkability for Active Ageing: Fostering Inclusive and Equitable Design in Metropolitan Peripheries

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Abstract

Health inequalities in urban peripheries disproportionately affect older populations, who face barriers in accessing essential services, public spaces, and safe infrastructure. These challenges are compounded by insufficient transport, deteriorating environments, and social exclusion, making ageing in peripheral areas particularly vulnerable.

This paper positions walkability as a strategic tool for promoting active ageing, health equity, and spatial justice. Moving beyond narrow definitions of pedestrian infrastructure, walkability is reframed as a multidimensional concept that integrates physical, social, environmental, and governance dimensions.

The paper draws on a systematic review of international frameworks and indicators, combined with empirical insights from participatory practices, to develop a framework of eight interrelated dimensions: connectivity and accessibility, safety and security, environmental quality, public space and amenities, land use and services, social inclusion, mobility behaviour, and governance tools. The framework highlights how walkable environments can enhance autonomy, inclusion, and well-being among older adults while addressing the compounded disadvantages of peripheral neighbourhoods.

Findings show that walkability must be conceived as more than infrastructure. Inclusive and participatory approaches - such as co-design workshops, mobility mapping, advisory boards, and participatory budgeting - are essential to align interventions with the lived experiences of ageing populations and to counter persistent cycles of neglect in peripheries.

In summary, fostering walkable environments in metropolitan peripheries is both a necessity - to ensure equitable access, healthier ageing, and community resilience - and an opportunity - to align urban regeneration strategies with international agendas. This paper contributes a novel framework that integrates walkability, ageing, and peripheral urban regeneration, offering a foundation for future research and practice.

Keywords

Walkability, active ageing, urban peripheries

1. Introduction

Urban peripheries, often marked by insufficient public transportation, limited access to essential services, and deteriorating infrastructure, present significant challenges for ageing populations. These areas are typically home to older adults who may face greater difficulty accessing healthcare, community facilities, and public spaces, leading to marked inequalities. The lack of walkable environments in peripheral neighbourhoods intensifies problems such as social isolation, physical inactivity, and reduced mobility, all of which undermine autonomy and overall quality of life (Guida et al., 2022). As urban planning and investment often prioritise central areas, peripheral zones are neglected, leaving ageing residents particularly vulnerable to the compounded effects of spatial and social exclusion.

In this context, walkability emerges as a key determinant of equity and active ageing. Traditionally associated with pedestrian infrastructure, walkability is increasingly recognised as a multidimensional concept that encompasses safe and accessible streets, proximity to essential services, environmental quality, and opportunities for social interaction (Southworth, 2005; Baobeid et al., 2021; Kim et al., 2024). Walkable environments not only facilitate mobility and physical activity but also strengthen community ties, reduce isolation, and support healthier ageing trajectories. For older adults, especially in underserved peripheral areas, walkability is thus central to maintaining independence, well-being, and meaningful participation in community life.

At the same time, policy frameworks such as the WHO's Age-Friendly Cities and Communities initiative (WHO, 2007; WHO, 2015) and the EU Green Paper on Ageing (European Commission, 2021) highlight the need to embed accessibility, inclusiveness, and participation into urban development. These agendas stress that equitable access to urban opportunities must extend beyond city centres to include peripheral neighbourhoods, where demographic ageing intersects most strongly with spatial inequalities. Incorporating older adults' lived experiences through participatory tools—such as co-design workshops, mobility mapping, advisory boards, and participatory budgeting—further enhances the effectiveness and inclusivity of interventions (Carroll & Nørtoft, 2022; Younes, Marques, & McIntosh, 2024).

Against this backdrop, the aim of this paper is to propose walkability as a strategic tool for promoting health equity and spatial justice in metropolitan peripheries, with a specific focus on improving outcomes for ageing populations. By integrating measurable indicators with participatory approaches, the paper advances a multidimensional framework that links walkability, active ageing, and urban regeneration. This framework seeks to guide policymakers, planners, and local governments in fostering more inclusive, accessible, and resilient urban environments that address inequalities while supporting the active ageing process.

2. Conceptual background

2. 1. Spatial Inequalities, Place and Walkability

The concept of place in urban studies has evolved from static geography to a multidimensional construct shaped by social, cultural, economic, and material factors (Massey, 1994). Place is a living context, produced through governance, mobility, and social relations, and central to understanding how spatial inequalities are created and sustained.

Such inequalities are particularly acute in metropolitan peripheries, where underinvestment, fragmented networks, and limited public services lead to neglected public spaces, poor transport, and restricted access to healthcare, education, and recreation (Soja, 2010). These deficits isolate communities and reinforce marginalisation.

Ageing populations are disproportionately affected, as older adults depend heavily on their immediate surroundings for mobility, services, and social interaction. Inadequate pedestrian infrastructure, scarce green areas, and limited opportunities for participation heighten risks of exclusion, declining autonomy, and health vulnerabilities (Buffel, Handler, & Phillipson, 2019).

In this context, walkability emerges as both an indicator and a corrective tool for inequality. Defined as the degree to which the built environment supports safe, comfortable, and accessible walking (Southworth, 2005), walkability enhances access to services, fosters community engagement, and strengthens inclusion (Leyden, 2003). Conversely, poor walkability in peripheries exacerbates socio-spatial disadvantage (Guida et al., 2022; Oppido et al., 2023).

Improving walkability is therefore not only a design issue but a strategy for social justice. Accessible and connected pedestrian environments enable participation for all residents, while for older adults they are critical to autonomy, well-being, and reclaiming public space as a shared good (Gehl, 2010; Lefebvre, 1996; Cysek-Pawlak & Pabich, 2020; Sonta & Jiang, 2023).

2.2. Active Ageing and Urban Regeneration

The concept of active ageing, as defined by the World Health Organization (WHO), refers to the process of optimizing opportunities that enable and support autonomy, inclusion, health, and social well-being throughout the life course (WHO, 2002). Urban environments play a central role in shaping these outcomes, as they directly influence access to essential services, mobility, social interaction, and overall quality of life for older adults.

In urban peripheries, these challenges tend to be amplified due to reduced investment, spatial segregation, and limited accessibility to public services and infrastructure, which leads to spatial and social exclusion of ageing populations. Urban regeneration in peripheral areas must account for the needs of an ageing population by prioritizing accessibility, safety, and inclusiveness.

Consequently, urban regeneration policies can be improved by the knowledge and experience of older adults, as well as by the sense of connection and active participation they contribute to their local communities (Buffel et al., 2012). Incorporating active ageing principles into regeneration strategies thus reframes older residents not as passive recipients of care, but as co-creators of more inclusive urban environments. By embedding their voices in planning and design processes, urban regeneration initiatives can promote intergenerational solidarity, strengthen community resilience, and ensure that revitalized spaces not only meet functional demands but also foster dignity, belonging, and social justice for ageing populations.

Linking local urban regeneration initiatives with these policy frameworks strengthens the case for embedding active ageing principles in urban transformation, aligning demographic, social, and spatial justice agendas within the broader goals of sustainable and inclusive European cities.

2.3 Urban Design Tools: Participatory and Localized Approaches

Participatory and localized approaches are increasingly vital for designing environments that meet the needs of ageing populations. Traditional planning often neglects older adults’ lived experiences, reinforcing mobility barriers, isolation, and exclusion. To counter this, innovative tools involve older residents directly in shaping their environments.

Co-design workshops, community walks, and mobility mapping enable older adults to identify priorities such as safe paths, lighting, and seating, as seen in Copenhagen and Melbourne (Carroll & Nørtoft, 2022; City of Melbourne, 2020). Institutional mechanisms, including senior advisory boards in Vancouver, participatory budgeting in Porto Alegre, and New York’s Age-Friendly Neighbourhoods program, integrate older voices into policy-making. Barcelona’s Superblocks initiative illustrates how localized interventions can enhance walkability and social interaction. Digital platforms such as Calgary’s Engage expand participation opportunities (Levenda et al., 2020).

Despite these advances, many tools still overlook ageing-specific challenges such as limited mobility, sensory impairments, and cognitive decline, particularly in underserved peripheries. Addressing this requires participatory approaches that foreground diverse ageing experiences, ensuring solutions are responsive and context-specific. In peripheral areas with scarce public transport, improving walkability through safe pedestrian routes, accessible services, and inclusive public spaces is especially critical.

Ultimately, participatory and localized design tools complement broader strategies of reducing spatial inequalities and fostering active ageing. They offer practical pathways to embed equity and inclusion principles into the everyday realities of city life.

3. Toward a Framework for Walkability and Inclusive Urban Tools

A walkability framework for active ageing is essential to assess and enhance accessibility, mobility, and the overall quality of urban environments. It must integrate both quantitative and qualitative dimensions, addressing not only physical infrastructure but also the social and experiential aspects of place. This approach allows a fuller evaluation of how cities support autonomy, inclusion, and well-being among older adults, while providing planners and policymakers with tools to monitor progress and reduce inequalities.

Walkability indicators typically measure physical features such as street connectivity, sidewalks, lighting, safety, and proximity to services (Southworth, 2005; Molaei et al., 2021). However, they must also capture broader factors, including access to healthcare, green spaces, and community centres (Gauvin et al., 2012), as well as social interaction and engagement, which mitigate isolation and support mental health (Leyden, 2003).

Indicators alone are insufficient. Effective frameworks must embed participatory and localized approaches, ensuring older adults’ lived experiences inform planning. By combining measurable indicators with participatory practices, cities can enhance walkability, foster active ageing, and strengthen community well-being.

The framework was developed through: (1) Literature Review and Indicator Mapping – drawing from international frameworks, policy guidelines, and ageing research (e.g., WHO, 2015; Living Streets, 2022). Indicators were grouped into categories addressing the physical environment, safety, social inclusion, and governance; (2) Participatory and Localized Approaches – analysing case studies in Copenhagen, Melbourne, Vancouver, New York, Barcelona, and Porto Alegre. Tools such as co-design workshops, mobility mapping, advisory boards, participatory budgeting, and digital platforms (Levenda et al., 2020; Living Streets, 2022) showed how older adults’ insights can shape inclusive environments.

The corpus analysed collectively contribute to a multidimensional understanding of walkability and age-friendliness, bringing together urban design principles (Southworth, 2005; Alves et al., 2020), policy and planning guidelines (WHO, 2015; WHO, 2018; Bevan & Croucher, 2011), and practice-oriented approaches (Living Streets, 2022; Healthy Streets, 2021; Walk21, 2019).

Table 1 synthesises the main contributions from academic, policy, and practice-oriented sources. Despite differences in scope, a strong convergence emerges around the need for integrated approaches that go beyond infrastructure provision.

Author	Year	Ittle	Indicators
Michael Southworth	2005	Designing the Walkable City	(1) connectivity (presence of sidewalks and other pedestrian paths and by the degree of path continuity and absence of significant barriers); (2) linkage with other modes; (3) fine grained and varied land use patterns (local serving uses); (4) safety (both from traffic and social crime); (5) path quality (including width, paving, landscaping, signing, and lighting); (6) path context (including street design, visual interest of the built environment, transparency, spatial definition, landscape, and overall explorability).
Department for Communities and Local Government - Mark Bevan and Karen Croucher	2011	Lifetime Neighbourhoods	<u>Creating walkable environments:</u> Comfortable; Connected; Conspicuous; Convenient; Convivial <u>Evidence based design guidance on street environments:</u> adjacent and shared use (cyclists and pedestrians) of footways and footpaths; bus stops and shelters; changes in level of footways and footpaths; kerbs, including tactile dropped kerbs of footways and footpaths; materials of footways and footpaths; pedestrian crossings; public toilets; seating; signage; street art; street greenery; widths of footways and footpaths <u>Public open spaces and parks:</u> good maintenance; having appropriate facilities; no heavy traffic en route; safety; trees and plants and activities to watch <u>Vibrant services within neighbourhoods:</u> accessibility within shops; contributing to sociable spaces within neighbourhoods; local access to shops; the range of products available within neighbourhoods (such as access to fresh food); volunteering and employment
(WHO) World Health Organization	2015	Measuring the age-friendliness of cities: A guide to using core indicators	<u>Core indicators:</u> (1) equity (measuring the level of inequality across reference groups); (2) accessibility of the physical environment (measuring, for example, the neighbourhood's walkability, accessibility of public spaces and accessibility of public transportation stops); (3) inclusiveness of the social environment (measuring, for example, positive social attitude toward older people, engagement in volunteer activity and socio-cultural activity, participation in local decision-making, and availability of health and social services). <u>Supplementary indicators</u>
(WHO) World Health Organization	2018	Age-friendly environments in Europe - Indicators, monitoring and assessments	<u>Domain 1. Outdoor environments:</u> 1.1 Accessibility of public spaces and buildings; 1.2 Neighbourhood walkability; 1.3 Public safety <u>Domain 2. Transport and mobility:</u> 2.1 Accessibility of priority vehicle parking; 2.2 Accessibility of public transportation stops; 2.3 Accessibility of public transportation vehicles; 2.4 Availability and accessibility of public transport <u>Domain 3. Housing:</u> 3.1 Ability to age in place; 3.2 Accessibility of housing; 3.3 Availability and affordability of housing; 3.4 Housing programmes and resources; 3.5 Safety at home <u>Domain 4. Social participation:</u> 4.1 Accessibility of participation opportunities; 4.2 Engagement in lifelong learning; 4.3 Engagement in sociocultural activity; 4.4 Opportunities for participation; 4.5 Participation in leisure-time physical activity in a group <u>Domain 5. Social inclusion and non-discrimination:</u> 5.1 Availability of intergenerational activities; 5.2 Influence in the community; 5.3 Positive social attitude towards older people; 5.4 Sense of belonging <u>Domain 6. Civic engagement and employment:</u> 6.1 Engagement in care and volunteer activity; 6.2 Engagement in paid employment; 6.3 Participation in local decision-making; 6.4 Training and support <u>Domain 7. Communication and information:</u> 7.1 Assistance available; 7.2 Availability of information; 7.3 Internet access; 7.4 Usability of information materials <u>Domain 8. Community and health services:</u> 8.1 Access to health and dental care; 8.2 Availability of home- or community-based services; 8.3 Emergency preparedness; 8.4 Supportive health services <u>Outcome indicators - health and well-being of older people:</u> (1) Educational attainment; (2) Financial security; (3) Health behaviour & risk factors; (4) Independent living; (5) Quality of life; (6) Social connectedness
Walk21	2019	Urban Mobility Indicators for Walking and Public Transport	<u>A. Comfort and Safety:</u> A1. Urban Experience; A2. Safety; A3. Security; A4. Walking Infrastructure; A5. PT Infrastructure; A6. Operational Performance; A7. Vehicle Quality; A8. Impact of motorised traffic on Walkability <u>B. Service Demand:</u> B1. Daily Trips <u>C. Connecting Destinations:</u> C1. Access to Public Transport Stops; C2. Access to Jobs and Services <u>D. Support and Encouragement:</u> D1. Information; D2. Availability of Walking Amenities; D3. Affordability; D4. Incentives

Table 1. Approaches to walkability and age-friendly environments from multiple authors and organizations

Fernando Alves, Sara Cruz, Anabela Ribeiro, Ana Bastos Silva, João Martins, Inês Cunha	2020	Walkability Index for Elderly Health - A Proposal	<u>1. Urban Tissue:</u> Existence of obstacles (EoO); Existence of stai (EoS); Land use mix (LUM); Pedestrian surface quality (PSQ); Sidewalks existence and width (SEW) (Average of SE and SW) Sidewalks existence (SE); Sidewalks existence and width (SE) (Average of SE and SW) - Sidewalks width (SW); Traffic Stre intersections (TSI) <u>2. Urban Scene:</u> Existence of trees, vegetation (ETV); Existence urban furniture (EUF) <u>3. Safety:</u> Diversity of information signs (DIS); Street lighting qual (SLQ)
Healthy Streets	2021	The 10 Healthy Streets Indicators - Healthy Streets Approach	(1) Clean air; (2) Easy to cross; (3) Everyone feels welcome; (4) N too noisy; (5) People choose to walk and cycle; (6) People feel relaxe (7) People feel safe; (8) Places to stop and rest; (9) Shade and sheltr (10) Things to see and do
Living Streets	2022	Walking for everyone, making walking and wheeling more inclusive	<u>Theme 1 - Improving governance, planning and decision making:</u> 1. Develop inclusive walking and wheeling plans; 1.2 Dedicate long-ter funding for making walking and wheeling inclusive, accessible ar desirable; 1.3 Take steps to ensure policy decisions are based r diverse voices, especially those of groups often marginalized; 1.4 Capture better walking and wheeling data for different groups, ar invest more in research; 1.5 Embed proximity to the things peop need into spatial planning by adopting a ‘20-minute neighbourhoo approach; 1.6 Invest significantly in public transport across the U especially buses <u>Theme 2 - Creating better places for everyone to walk and wheel:</u> 2. Develop national design guidance for walking and wheelin infrastructure; 2.2 Take steps to improve road safety, air quality ar reduce physical severance by roads; 2.3 Ensure pavement space reserved and maintained for people walking and wheeling; 2.4 Prioritise design measures to improve personal safety <u>Theme 3 - Supporting everyone to walk and wheel:</u> 3.1 Raise the prof of walking and wheeling, and equip people with the information ar tools they need; 3.2 Invest in walking and wheeling programmes improve confidence and ability, including social prescribing; 3.3 Reverse the decline in childhood independent mobility by prioritisi children’s needs in public spaces
Sport England, Active Travel England and Office for Health Improvement and Disparities	2023	Active Design - Creating active environments through planning and design	<u>Foundational Principle:</u> 1. Activity for all <u>Supporting active travel:</u> 2. Walkable Communities; 3. Providing connected active travel routes; 4. Mixing uses & co-locating facilities <u>Active, High-Quality places & spaces:</u> 5. Network of multi-functional open spaces; 6. High-quality streets & spaces; 7. Providing activity infrastructure; 8. Active buildings, inside and out <u>Creating & Maintaining Activity:</u> 9. Maintaining high-quality flexible spaces; 10. Activating spaces

Building on this literature and the methodological combination of indicator mapping and participatory approaches, a multidimensional framework was developed. It is structured into eight interrelated dimensions, which function simultaneously as assessment criteria and guidelines for intervention:

- Connectivity and Accessibility: Sidewalk presence, width, and continuity (Southworth, 2005; Alves et al., 2020); Linkage to public transport and modal integration (Southworth, 2005; Walk21, 2019); 20-minute neighbourhood concept (Living Streets, 2022); Barrier-free paths, sidewalks, and crossings (Bevan & Croucher, 2011; WHO, 2015); Path context and visual interest (Southworth, 2005);
- Safety and Security: Traffic and pedestrian safety (Southworth, 2005; Walk21, 2019; Healthy Streets, 2021); Perceived and actual personal security (WHO, 2018; Alves et al., 2020; Living Streets, 2022); Street lighting and signage (Alves et al., 2020; Healthy Streets, 2021);

3. Environmental Quality: Air and noise quality (Healthy Streets, 2021); Shade, shelter, and green infrastructure (Bevan & Croucher, 2011; Healthy Streets, 2021); Cleanliness and maintenance (Bevan & Croucher, 2011);
4. Public Space and Amenities: Seating, toilets, and rest areas (Bevan & Croucher, 2011; Healthy Streets, 2021); Things to see and do / urban interest (Southworth, 2005; Healthy Streets, 2021); Availability of public art and signage (Bevan & Croucher, 2011); Places to gather, stop and rest (WHO, 2018; Healthy Streets, 2021);
5. Land Use and Local Services: Land use diversity (Southworth, 2005; Alves et al., 2020); Access to shops and daily services (Bevan & Croucher, 2011; WHO, 2018); Proximity to health and community services (WHO, 2018; Walk21, 2019);
6. Social Inclusion and Participation: Inclusive public space design (WHO, 2015; WHO, 2018; Living Streets, 2022); Opportunities for civic engagement and volunteering (WHO, 2018; Living Streets, 2022); Sociocultural activity and community networks (WHO, 2015; WHO, 2018);
7. Mobility and Travel Behaviour: Walking frequency and travel behaviour data (Walk21, 2019; WHO, 2015); Daily trip counts and patterns (Walk21, 2019); Ease of crossing and pedestrian priority (Healthy Streets, 2021);
8. Governance and Implementation Tools: Dedicated funding and inclusive planning (Living Streets, 2022); Use of diverse data and co-production in decision making (Living Streets, 2022; Levenda et al., 2020); Monitoring, assessment and core indicators for ageing (WHO, 2015; WHO, 2018).

By integrating these eight dimensions, the proposed framework provides a holistic basis for assessing and enhancing walkability in metropolitan peripheries through the lens of active ageing. It highlights the interconnections between mobility, accessibility, health, and social inclusion, while emphasising the importance of multi-scalar, interdisciplinary, and participatory strategies. In doing so, it positions walkability as a cornerstone of spatial justice, age equity, and urban sustainability.

The study demonstrates that walkability constitutes a strategic entry point for addressing health equity and spatial justice in metropolitan peripheries. The proposed eight-dimension framework—connectivity and accessibility, safety and security, environmental quality, public space and amenities, land use and services, social inclusion, mobility behaviour, and governance tools—provides a comprehensive structure for assessing and improving urban environments for ageing populations.

Three main results emerge. First, walkability must be understood as a multidimensional concept that integrates physical, social, environmental, and governance factors rather than being limited to pedestrian infrastructure. Second, deficiencies in walkability are particularly acute in peripheral areas, where infrastructural neglect and service gaps reinforce cycles of exclusion. Third, participatory practices such as co-design workshops and mobility mapping substantially improve the inclusivity and effectiveness of interventions, embedding older

adults' lived experiences into planning processes.

Policy implications include the integration of walkability indicators into urban governance frameworks, prioritisation of investment in peripheral areas, and alignment with international agendas such as the WHO Age-Friendly Cities initiative and the EU Green Paper on Ageing. For practice, the framework equips planners and designers with actionable criteria for creating inclusive, resilient, and age-friendly environments that promote active ageing and social cohesion.

4. Conclusions

This paper has shown that walkability can serve as a strategic urban tool to foster active ageing, health equity, and spatial justice, particularly in metropolitan peripheries where spatial and social inequalities are most pronounced (Sonta & Jiang, 2023). Drawing from a diverse body of frameworks and indicators, we developed an integrated perspective that links the physical environment—including connectivity, safety, public amenities, and environmental quality—to older adults' mobility, independence, and participation in community life (Molaei et al., 2021). These dimensions are especially critical in peripheral areas, where infrastructure and services are often lacking or poorly maintained.

However, the research also demonstrates that walkability cannot be reduced to physical infrastructure alone. Inclusive urban design approaches that centre the lived experiences of older residents are indispensable. Participatory and localised methods—such as co-design workshops, mobility mapping, advisory boards, and participatory budgeting—offer concrete ways to ensure that urban development responds to the real needs of ageing populations (Gehl, 2010; Younes, Marques, & McIntosh, 2024).

Embedding these practices into urban regeneration and planning processes is essential to counter the effects of social exclusion and spatial segregation that commonly affect peripheral neighbourhoods.

In this light, fostering walkable environments in metropolitan peripheries is not only a question of accessibility or mobility, but a broader step toward building inclusive, just, and age-friendly cities. By integrating walkability into urban policies, cities can support healthier ageing, strengthen community ties, and reduce inequalities across demographic and geographic lines (Younes et al., 2024). As metropolitan areas face demographic shifts, climate pressures, and socio-economic challenges, placing walkability at the heart of urban regeneration and equity strategies becomes both a necessity and an opportunity for promoting long-term resilience, intergenerational solidarity, and social cohesion (Talen, 2021).

Future research should test the proposed framework across different metropolitan contexts, with particular attention to peripheral neighbourhoods, and explore how walkability indicators can be integrated with broader agendas such as climate-neutral and smart cities. Such investigations will be crucial for refining the framework's applicability and ensuring its contribution to more sustainable and equitable urban futures.

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Customizing Urban Navigation: AI-Powered Walking as a Service (WaaS) for Enhanced Urban Livability and Sustainability, Bridging Social Inclusion and Sustainable Mobility Through Personalized Walking Experiences

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Abstract

Urban streets serve multiple functions beyond transportation, yet current navigation systems address only distance and time considerations while neglecting crucial qualitative dimensions of walking. This gap affects various user groups differently: residents face unnecessary environmental hazards, tourists struggle with unfamiliarity, and vulnerable populations encounter accessibility barriers. TurnRight proposes an AI-powered Walking as a Service (WaaS) solution that analyzes real-time environmental, safety, and experiential data to generate personalized walking routes based on user-selected parameters. The platform utilizes an innovative chat-based interface combined with interactive mapping to understand user preferences and provide tailored recommendations. Our solution stands apart from traditional navigation systems through its ability to dynamically adapt to changing environmental conditions and individual needs, making urban exploration more accessible, safe, and enjoyable. Preliminary testing shows strong user engagement, with over 95% of survey participants expressing interest in personalized routes. By enhancing urban walking experiences through personalized AI-driven navigation, TurnRight promotes sustainable mobility, improves urban livability, and addresses key challenges in contemporary urban environments. Implementation is projected to yield measurable improvements in pedestrian safety, accessibility, physical and psychological health, convenience, walking enjoyment, and environmental awareness across diverse demographic groups.

Keywords

Walking as a service, AI agent, urban mobility, personalized navigation, data-driven

1. Introduction

Urban streets are complex spaces serving social, natural, and mobility functions. As cities transition towards more sustainable and livable environments, innovative approaches to street design, planning, and utilization are increasingly vital (Gehl, 2013). Although significant research has traditionally concentrated on improving physical infrastructure and public transportation systems, less emphasis has been placed on comprehensively enhancing the pedestrian experience, particularly through the lens of specific urban design qualities (Ewing & Handy, 2009).

Walking is recognized as one of the most sustainable, healthy, and universally accessible forms of urban mobility. However, its widespread adoption is often hindered by numerous barriers (Speck, 2012). While walkable neighborhoods foster social capital and a general sense of community safety (Leyden, 2003), other external factors, such as air pollution, excessive noise, and specific safety concerns, can independently deter pedestrians and diminish their overall experience. This is especially true for tourists and visitors in unfamiliar cities, who frequently struggle to identify safe, comfortable, and personally engaging walking routes.

A significant challenge for tourists is the “time paradox” they encounter while exploring unfamiliar cities. With limited time available, visitors struggle with time management for exploration activities. Conventional navigation systems provide no guarantees regarding optimal use of this limited time, leading to either rushing through attractions or missing important sites altogether. This uncertainty frequently results in disappointment with both the city and the overall travel experience.

Traditional navigation systems and applications primarily optimize routes based on distance and time, failing to account for the multidimensional nature of walking experiences. This one-size-fits-all approach neglects individual preferences and situational factors that significantly impact user satisfaction and willingness to walk.

This paper presents TurnRight, an AI-powered Walking as a Service (WaaS) platform designed to address these challenges by providing personalized, context-aware pedestrian navigation. By integrating diverse data sources and utilizing artificial intelligence, TurnRight aims to transform urban walking experiences, promote sustainable mobility, and contribute to more inclusive, enjoyable, and healthy urban environments.

2. Literature Review

2.1 Urban Walkability and Pedestrian Experience

The concept of walkability has gained significant attention in urban studies, with researchers identifying multiple factors that influence pedestrian experiences. According to Ewing and Cervero (2010), the “5Ds” of density, diversity, design, destination accessibility, and distance to transit significantly impact walking behavior. Speck (2012) further refines this

through his “General Theory of Walkability,” suggesting that a walk must be useful, safe, comfortable, and interesting to encourage pedestrian activity.

Research by Gehl (2013) emphasizes the importance of human-scaled environments and the quality of public space in promoting walking. Similarly, Mehta (2008) identifies five dimensions of pedestrian-friendly streets: physical amenities and facilities, land use patterns, street scale and morphology, personal safety, and quality of the environment.

However, these physical and environmental factors interact with individual preferences and demographics in complex ways. Studies by Brown et al. (2007) demonstrate that perceptions of walkability vary significantly across demographic groups, with factors such as age, gender, and mobility limitations influencing walking decisions.

2.2 Technology and Urban Mobility

The application of technology to urban mobility has primarily focused on vehicular transportation, with less attention given to pedestrian-specific solutions (Pojani & Stead, 2015). While navigation applications like Google Maps and Waze have revolutionized car travel, pedestrian routing typically remains limited to shortest-path algorithms (Golledge, 1995).

Recent research has begun to explore alternative approaches to pedestrian navigation. Quercia et al. (2014) developed “happy maps” that can recommend emotionally pleasing routes rather than merely short ones. Similarly, Rossetti et al. (2019) proposed an approach to pedestrian navigation that considers environmental factors such as air quality and noise levels.

The emergence of artificial intelligence and big data analytics presents new opportunities for personalized pedestrian navigation. Machine learning algorithms can identify patterns in pedestrian behavior and preferences, potentially enabling more tailored routing recommendations (Guo et al., 2020). Additionally, the integration of various data sources, including environmental sensors, crime statistics, and social media, can provide a more comprehensive understanding of the urban walking environment (Batty, 2013).

2.3 State of the Art: Digital Pedestrian Navigation

Building on the academic explorations outlined above, recent years have seen the rise of digital ecosystems that operationalise or commercialize pedestrian navigation. While mainstream navigation tools such as Google Maps or Apple Maps provide reliable directions, their pedestrian mode is still primarily optimized for shortest-path efficiency, with limited incorporation of qualitative dimensions such as safety, air quality, or experiential richness. Citymapper has introduced some context-aware features (e.g., multimodal integration, live disruptions), but its pedestrian focus remains narrow.

Beyond general-purpose navigation, there is a growing set of experience-driven platforms.

Applications like GetYourGuide, Tiqets, or Viator curate walking tours, often enhanced by local storytelling or bundled with tick-ets to attractions. However, they typically offer static itineraries, not dynamic, personalized routes responsive to a user’s starting point, time constraints, or personal preferences. Similarly, audio/AR city guides (e.g., De-tour/Apple Guides, VoiceMap) provide immersive narratives but are limited to predesigned trails rather than adaptive navigation.

In the outdoor sector, products such as AllTrails and Komoot demonstrate the potential of rich, user-generated POI data, offline functionality, and alternative routing. Yet they are oriented toward hiking and recreation ra-ther than dense urban environments with layered constraints of accessibility, safety, or air quality.

TurnRight differentiates itself by:

- integrating multi-layer urban data (environmental, safety, accessibility, cultural) into the routing logic, rather than treating them as afterthoughts;
- providing a conversational interface that captures intent in natural terms (e.g., “two hours from my hotel, in-terested in food and architecture”);
- enabling real-time adaptation when conditions change (air, crowding, closures);
- combining A→B routing and circular walks under explicit time budgets, balancing efficiency with discovery.

Thus, while research prototypes have illustrated the feasibility of qualitative routing, and commercial platforms have shown demand for curated experiences, there is still a gap for a personalized, adaptive, data-driven pe-destrian assistant. TurnRight positions itself in this space, bridging academic insights and practical deployment in urban contexts.

3. The TurnRight Approach

3.1 Conceptual Framework

TurnRight operates through an intuitive AI-powered interface combining chat and map functionality:

Chat-Based Navigation: Users interact with TurnRight through a conversational interface, sharing their preferences, destination, or available walking time. The AI assistant asks personalized questions to understand specific needs and then recommends optimal routes.

Interactive Map Display: Based on the conversation, the system generates customized routes on the map with detailed information, color-coding segments according to selected parameters (e.g., safety, air quality, or points of interest) and assigning overall quality scores to each route option.

TurnRight uses artificial intelligence (AI) to analyze real-time and historical data, generating personalized walking routes based on user-selected parameters (filters or layers). These filters include air quality, noise levels, crime rates, route “greenness,” accessibility, points of interest, and more, applied individually or combined. Route conditions are dynamically

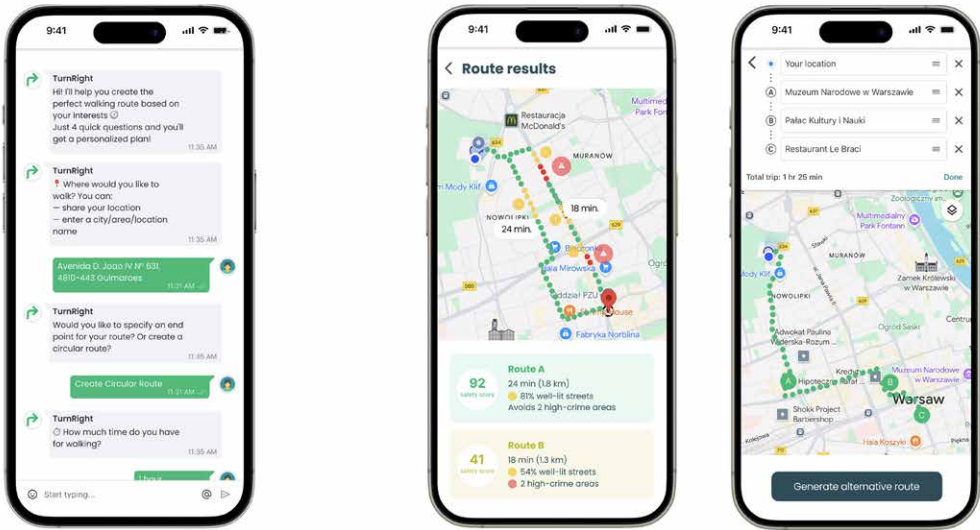


Figure 1. TurnRight interface: AI-powered chat navigation with personalized route selection and safety scoring

updated in real-time using AI agent parsing. Unlike standard navigators, TurnRight suggests routes with color-coded segments (red/yellow/green) based on selected filters, assigning each a percentage score (e.g., “crime” filter: Route 1 - 32%, Route 2 - 11%, Route 3 - 57%). Ratings update in real-time, improving safety, convenience, and time efficiency.

3.2 Technology Architecture

The TurnRight platform employs a multi-layered architecture:

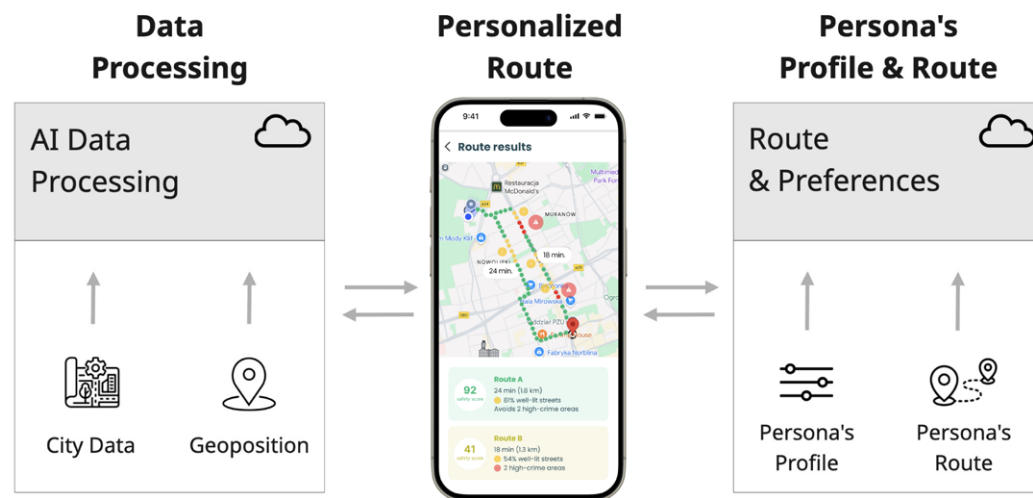
- Data Collection Layer: Integrates data from various sources, including environmental sensors, crime statistics, traffic monitoring systems, weather services, and user feedback.
- AI Processing Layer: Analyzes collected data using machine learning algorithms to identify patterns, predict conditions, and personalize routing recommendations.
- User Interface Layer: Provides an intuitive interface for users to specify preferences, view route options, and receive real-time guidance.

3.3 Data Sources and Integration

TurnRight integrates data from multiple sources to provide comprehensive routing recommendations:

- Environmental Data: Air quality sensors, noise level monitors, weather services.
- Safety Data: Crime statistics, street lighting information, pedestrian accident records.
- Infrastructure Data: Sidewalk quality, pedestrian crossings, accessibility features.
- Points of Interest: Cultural attractions, scenic views, green spaces, cafes, and other amenities.

These data sources are integrated through a standardized API framework, allowing for flexible expansion and incorporation of additional data as it becomes available.



4. Projected Improvements and Impacts

4.1 Safety and Accessibility

Implementation of TurnRight is projected to yield significant improvements in pedestrian safety and accessibility:

Perceived Safety: 10-20% improvement through avoidance of high-crime areas and better situational awareness.

Pedestrian-Vehicle Collision Risk: 5-15% reduction, particularly in high-traffic urban areas.

Perceived Accessibility: 15-30% improvement for people with mobility limitations.

Walking Trips Among Vulnerable Groups: 10-20% increase due to enhanced confidence and comfort.

4.2 Health and Environmental Benefits

TurnRight's emphasis on air quality, green spaces, and active mobility is expected to generate multiple health and environmental benefits:

Psychological Well-being: 15-25% improvement through exposure to green spaces and pleasant environments.

Physical Activity Levels: 10-30% increase due to more frequent and enjoyable walking experiences.

Air Pollution Exposure: 5-15% reduction through routing that minimizes exposure to high-pollution areas.

Carbon Footprint: Reduction in urban transport emissions as more people choose walking over short car trips.

Figure 2. TurnRight data architecture: Integration of urban data, AI processing, and user preferences for personalized route generation

4.3 Urban Experience and Engagement

By enhancing the quality of walking experiences, TurnRight is expected to foster greater engagement with urban environments:

Walking Enjoyment: 15-30% increase through more attractive and interesting routes.

Leisure Walking Frequency: 10-20% increase as walking becomes more pleasurable.

Environmental Awareness: 15-30% improvement through exposure to diverse urban environments.

Tourist Experiences: Enhanced exploration and discovery through personalized routing that connects landmarks and attractions.

5. Market Correlation and User Research

5.1 Market Analysis and Correlation

The TurnRight solution addresses a significant market opportunity at the intersection of smart tourism (€650B market) and urban mobility (€169.3B market). Our research reveals a strong correlation between urban mobility quality and tourism growth, with each 1% improvement in urban mobility associated with a 1.37% increase in tourist flow. This correlation underscores the potential economic impact of improved pedestrian experiences in urban environments.

5.2 User Research Findings

To validate the need for personalized walking routes, we conducted a comprehensive survey with pedestrians across different demographic groups. The results confirmed our hypothesis regarding navigation challenges:

- 27% of respondents currently use navigation apps for walking, while 29.4% choose their routes randomly, indicating a significant opportunity for improvement in walking route selection.
- Only 35.8% reported that they already know the best routes and stick to them, highlighting the need for better navigation for the majority of users.
- A significant 73.2% of respondents reported being frustrated when walking in unfamiliar cities (48.2% rarely, 25% occasionally).
- When asked about personalization preferences, 48.2% prioritized attractiveness (routes passing by interesting spots), 24.6% valued accessibility (clean air, quiet streets, barrier-free paths), and 23.6% emphasized safety features (well-lit routes with low crime risk).
- Most importantly, 95.9% of survey participants showed interest in personalized walking routes, with 40.2% responding "Yes, sure" and 55.7% saying "Maybe, depends on the situation."

5.3 User Testing Results

The economic implications of optimized urban navigation emerged as a significant finding from our field testing. When examining both time investment and experiential outcomes, the data revealed substantial efficiency differences between traditional and AI-assisted navigation approaches.

Conventional self-planned navigation required test participants to invest an average of 58 minutes in route planning and orientation activities. While this substantial time investment yielded generally positive outcomes (68% mean satisfaction rating), the resource efficiency of this approach proved questionable. Applying a standardized time valuation of €30/hour – consistent with average tourist opportunity cost estimates – the self-planning approach required approximately €29 worth of tourist time. This translates to a satisfaction-to-investment ratio of €0.43 per percentage point of satisfaction.

By contrast, TurnRight-assisted navigation demonstrated remarkable efficiency improvements. Users spent an average of just 4 minutes interacting with the application to achieve superior results – 73% mean satisfaction with resulting routes and experiences. The reduced time investment (approximately €2 of tourist time at standard valuation) produced a dramatically improved satisfaction-to-investment ratio of €0.03 per percentage point of satisfaction.

This 14.3× improvement in resource efficiency did not come at the expense of exploration quality. In fact, the data showed multiple experiential enhancements:

- 18% increase in unique points of interest encountered
- 23% reduction in reported orientation stress and cognitive load
- 32% improvement in discovery of unplanned but personally relevant locations

Participant interviews revealed several recurring themes explaining these outcomes. The elimination of “time anxiety” emerged as particularly significant – the confidence that available time would be optimally utilized allowed participants to engage more deeply with each location. Similarly, the reduction in cognitive navigation load permitted greater attentional resources to be directed toward the environment itself rather than wayfinding concerns.

Ultimately, these findings suggest that the time paradox in urban exploration represents not merely an inconvenience but a substantial economic inefficiency and experiential limitation that can be effectively addressed through contextually-aware route optimization.

6. Discussion

6.1 Contribution to Urban Mobility Transitions

TurnRight supports the transition from car-oriented to people-centered cities. We see walking not only as leisure but also as a credible option for short urban trips - from home to the bus stop, from a hotel to a museum, or from the office to a café.

The decision to walk depends on more than time or distance. Perceived safety, accessibility, comfort, and atmosphere often determine whether people choose to walk. By taking these into account, walking becomes more attractive. This has three main effects:

Social inclusion: routes adapted to mobility limitations or safety concerns expand access to the city for more groups.

Environmental sustainability: replacing short car trips with walking reduces emissions and traffic pressure.

Public health: walking promotes physical activity, while exposure to noise and pollution can be reduced.

6.2 Data-Driven Urban Planning

Aggregated, anonymized user data can provide cities with valuable insights. It can reveal hidden “desire lines” where people walk despite poor infrastructure, problem areas such as missing crossings or zones avoided at night, and spatiotemporal dynamics showing when and why streets feel less attractive. Such insights allow cities to evaluate street design through lived experience, not just traffic counts. This creates a bridge between big data and the qualitative aspects of everyday urban life, helping planners design more walkable, human-centered streets.

6.3 Limitations and Future Directions

It is important to acknowledge the current limitations:

- Data gaps and bias. Coverage varies by city, and proxies (e.g., lighting density for safety) can encode bias.
- Privacy. Behavioral data should always be opt-in, minimal, aggregated, and governed transparently. Lo-cal-first modes (no data sharing) and clear model documentation are essential.
- Risk of over-automation. If only one “optimal” route is suggested, exploration and playfulness may disappear. For this reason, TurnRight defaults to multiple alternatives and a “serendipity mode.”
- Evaluation metrics. Success should be measured not only by speed or satisfaction, but also by emotional outcomes (stress, curiosity), cognitive load, and equity (who benefits and who is excluded).
- Future roadmap. Integration with public transport, AR prompts for crossings or barriers, community-generated routes, and city dashboards are among the next development steps.

6.4 Does AI Humanize or De-Humanize Walking?

A central question is whether AI will ultimately humanize or de-humanize walking in cities by intermediating decisions that were once exclusively human - choosing where to go, when

to turn, or whether to get lost.

On the one hand, AI can humanize walking by lowering barriers: reducing fear, stress, and fatigue, and opening the city to those who might otherwise avoid walking due to insecurity, mobility constraints, or lack of time. In this sense, technology becomes an enabler of inclusion and confidence.

On the other hand, there is a clear risk of de-humanization. If an algorithm dictates a single path, the walk may lose elements of imagination, uncertainty, and chance discovery that have always been part of exploring a city. Critics in urban design have argued that optimisation tends to “flatten” the urban experience by reducing un-predictability and spontaneity.

Both perspectives are valid, and the outcome depends on design choices. If AI acts as an autopilot, compressing decisions into one “optimal” output, it narrows experience. But if it functions as a co-pilot — presenting plural alternatives, explaining trade-offs, adapting dynamically when preferences or conditions change, and leaving intentional space for wandering — it can actually expand the field of possibilities.

Our design vision for TurnRight is therefore not to replace human agency, but to support it: offering reassurance and transparency while still leaving room for improvisation and serendipity. Early pilot tests suggest that when time-anxiety is reduced, people notice their surroundings more and make more unplanned discoveries. This indicates that AI, if designed with openness, can enrich rather than flatten urban walking.

7. Conclusion

This paper introduced TurnRight, an AI-powered pedestrian navigation concept designed to make walking a credible and attractive alternative for short urban trips. By integrating multiple factors - time, personal interests, environmental conditions, and accessibility - into route generation, TurnRight demonstrates how walking can evolve from a default mode of movement into a tailored, enjoyable, and sustainable urban experience.

Our design vision is to position TurnRight as a co-pilot for walking. Instead of prescribing a single “optimal” path, it aims to provide qualitatively distinct alternatives - unique and personalized - explain the trade-offs behind them, and leave room for serendipity. In this way, TurnRight directly addresses critiques that optimisation may “flatten” the urban experience by removing unpredictability and chance encounters.

The broader contribution of this work is twofold. For cities, TurnRight supports sustainable mobility transitions: encouraging walking instead of short car trips, improving accessibility and safety, and generating privacy-preserving data that helps shape more human-centered streets. For researchers, it raises fundamental questions about how to measure the quality of walking, how to balance efficiency and exploration, and how AI can humanize - or de-humanize - everyday urban experience.

Future development will expand TurnRight into a scalable platform, integrating real-time

environmental data, offering plural routing options, and exploring new interfaces such as conversational agents and augmented reality prompts. The ultimate goal is not an autopilot that narrows choice, but a co-pilot that broadens it - empowering users, enriching discovery, and strengthening the role of walking in more sustainable, inclusive, and livable cities.

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Permeable City: Public Access Space

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Abstract

What is a permeable city? Considering that spatial permeability is a condition that promotes urban life and vitality, this research analyses public access paths in the context of a consolidated city, presenting the case of Vila Nova de Famalicão.

The map produced by Nolli in 1748 for the city of Rome allowed us to perceive public access space by breaking with the notion of the street as a conduit and presenting the ground floor of the city as the great stage for human activities. Adapting this concept of spatiality to the present day, it is clear that different types of collective access space enrich the dimension of public space and contribute to the broader condition of spatial permeability.

This article lists the characteristics underlying the permeability of the urban fabric and buildings, considering the combination of public and private sphere components. To address spatial permeability, we start from a base of bibliographic references on the subject and in-depth knowledge of the object of study.

The sample covers five contiguous blocks, on which public space is analysed from the pedestrian's perspective. The method used considers the application of a set of concepts, metrics and counts, represented in cartographic extracts, tables, graphs and illustrations.

As the research is in its early stages, it is expected that the analysis process will identify the different types of in-between spaces, their degrees of permeability and how the established permeability properties are evidenced. The result is expected to outline the continuities and complementarities of the pedestrian network, validate the selected concepts and determine the common denominator of spatial permeability. It is expected that the main public pedestrian network will be complemented by an informal pedestrian network of private spaces for public use, forming a broader permeable system of public access.

Keywords

Urban permeability, public access space, spatial analysis

1. Introduction

It is well known how urban design can shape the perception of a city. The layout of streets, the positioning of buildings and the distribution of activities are aspects that play an important role in people's relationships and how they move around in urban spaces. The ease of walking through well-connected streets, clear paths and alternative paths are characteristics that determine spatial permeability. The proposed approach aims to present a case study of a consolidated sector of the urban centre of Vila Nova de Famalicão, from which a set of spatial characteristics of five blocks will be analysed. The analysis of these five blocks aims to validate the methodology for extending the analysis to the entire study area, represented in Figure 2.

1.1 Urban Permeability

Urban permeability integrates several trends that address the enhancement of the urban environment. Within the concept of a responsive environment¹, permeability is considered one of the essential elements, referring to places that are accessible to people and where there are a number of alternative paths options. In this sense, it is understood that small blocks contribute advantageously to this urban dimension, given the more frequent opportunities to 'turn the corner'². In other words, spatial permeability is the correlation between connectivity and length that determines the possibility of path choices through and within an urban grid³.

To determine spatial permeability, quantitative methods have been used with methodologies that allow for an objective, systematic and comparable analysis of the urban form⁴. Graph theory is one of the techniques used, and its methodology can be applied to both the urban fabric and the built environment. Another widely used methodology is Spatial Syntax. This language is based on the theoretical foundations of social theory of space, focusing on the study of people's relationship with the urban fabric and the built environment⁵.

The way in which permeability is represented has varied, with cartographic representation being one of the mechanisms used over time. One of the main maps is engraved on a rock in Vale Camonica and shows the system of connections between buildings and places, representing the daily life of a Palaeolithic village⁶. Another highly influential cartographic reference is the one produced by Giambattista Nolli in 1748 for the city of Rome. This map is unique in that it uses figure-ground representation to highlight the morphology of the city, but above all to reveal the city's system of public access spaces. The fact that it combines open public space and interior public access space has led to a new way of looking at this spatial phenomenon. The representation was made using a large continuous and interconnected area, revealing the proportion between strictly private space (in black) and public access space (in white). This experiment showed how border or in-between spaces are of great interest to architecture and the city.

The methodology adopted in Nolli's plan is still inspiring today and is widely used in acade-

Figure 1. (page before) Mapping of study area



Figure 2. (right) Analysis sample: BB (Barreiros Block), VB (Vinova Block), FB (Famidoce Block), GB (Galiza Block)
Figure 3. (left) Identification of the sample in relation to the object of study

mic circles. Within this rationale, it can be seen that, in addition to public space, in-between spaces are part of a broader and more diverse system, which enriches the dimension of the former and ensures spatial diversity, interactions and varied appropriations. The ease with which people can move around the city and interact with each other can be improved by enhancing existing resources, thus contributing to bringing the city closer to the people.

1.2 Urban Context

In Portugal, studies have been carried out in this area for other urban realities⁷, namely for the city of Lisbon, with different focuses and methodologies. This research, through the use of quantifiable indicators, such as distances, and the identification of the physical characteristics of the city's ground floor, develops the analysis of public access space from the pedestrian's perspective. The aim is to demonstrate the existence of interconnected paths that enhance spatial permeability, based on the hypothesis that the urban centre of Vila Nova de Famalicão enjoys a condition formed by a typological set of spaces that contributes to urban permeability.

The greatest urban development of Vila Nova de Famalicão began in the 19th century. This context is particularly relevant in explaining the city's development in terms of its relatively recent urban matrix and the heterogeneity of its buildings and plot sizes. The older streets gave rise to urban fronts that later became part of blocks on which buildings were erected, especially in the late 20th century.

In addition to this recent land redistribution, between the 1980s and 1990s, the civil construction sector experienced strong urban growth, giving rise to multi-storey buildings and a set of new spaces on the ground floor. These new spaces appeared adjacent to buildings and also inside them, establishing a relationship with public space, but above all, a new way of managing private spaces for public use. These aspects represent various challenges, but they enhance the connection between paths, interlinking public and private spaces.

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2. Methodology

The methodology adopted is based on the exploration of concepts and the analysis of the ground floor of five contiguous blocks. The information collected is presented in cartographic extracts, tables and graphs. The selected blocks are used to identify the path options they offer, considering all possibilities for public access.

In order to systematise the process, the collection of information and the data obtained focus on the analysis of a) urban elements, b) in-between spaces and c) intersections in the public access system

2.1 Urban Elements

In the context of this research, urban elements refer to the set of structural components of the urban fabric designated as streets, blocks and buildings.

The street, associated with squares, parks and urban gardens, defines the public space par excellence and the stage on which daily life takes place, structurally and traditionally shaping the public space.

The block, as a space delimited by the crossing or intersection of roads, is an element with diverse characteristics that opens or closes to the urban fabric, predisposing itself to the integration of greater or lesser permeability within it or between its boundary and the public space.

The blocks under analysis were mostly built between the 1960s and 1990s of the 20th century and have the particularity of presenting a ground floor design with in-between spaces that enhance the diversity of occupation and experience.

The building, especially when it incorporates in-between spaces (e.g. arcades, passage-ways), ceases to be just a physical barrier and acts as a mediator of pedestrian circulation. The analysis of buildings with these characteristics, referred to as walkable buildings⁸ insofar as they have hybrid spaces⁹, allows us to identify different degrees of permeability depending on the type of in-between spaces they incorporate.

2.2 In-between.spaces

In-between spaces are the thresholds between public and private space, with varying degrees of permeability, capable of creating potential for use and diversity of spaces that can enliven built fronts and the rhythms of urban life.

This threshold can be characterised by porosity, a concept presented by Walter Benjamin¹⁰ in relation to the city of Naples, referring to the presence of recesses in the built frontage and urban space. In the context of this work, these recesses translate into in-between spaces.

The interpretation of the building, the relationship between buildings and the block, and

8. Sim, D. (2019) p. 96
9. Idem p. 164
10. Benjamin, Walter (1978), pp. 165 and 166
11. Costa, C. S. A., (2016), pp. 35–44
12. For example, Jeff Speck refers to doors and windows as porous, while David Mangin understands it to be the space that extends beyond the entrance (e.g. a public access corridor) and for Walter Benjamin it is any recess in the built frontage or urban space. The designation that defines the various conditions is also different: David Mangin calls the sequence of spaces categories, identifying the sequence as *passant / poreux / profond* (Mangin, D., (2023)), and Giselle Luzia Dziura designates the sequence accessibility / continuity / passage as levels or degrees of spatial permeability (Dziura, G. L. (2009)).
13. Bentley, I., Alcock, A., McGlynn, P., & Graham, S. (2005)



Figure 4. Set of cartographic extracts by in-between-spaces

Diagram 1. Characteristics of In-between-spaces



between the block and the urban fabric determine the type of permeability: local permeability when there is a passage or connectivity through the building, peripheral permeability when the building integrates arcades or galleries along the public space, and structural permeability when it is clear that the passage or connection integrates the urban fabric (for example, when a street passes under a building)¹¹.

For several authors¹², the concepts that define the properties of permeability in buildings vary in meaning. For this analysis, the terms accessibility, continuity, and connectivity are used. Accessibility is understood as the ability to enter or access a space, which is the most basic dimension of permeability and corresponds to the simple fact of allowing access.

Continuity refers to the extension of the path beyond the initial access, i.e. when the space is not only accessible but also allows the path to be extended.

Connectivity refers to the ability to cross and connect different points of the block or urban grid. Examples of this are the internal passages of shopping centres or galleries that connect streets. It is the property that contributes most to reducing distances and offering alternative

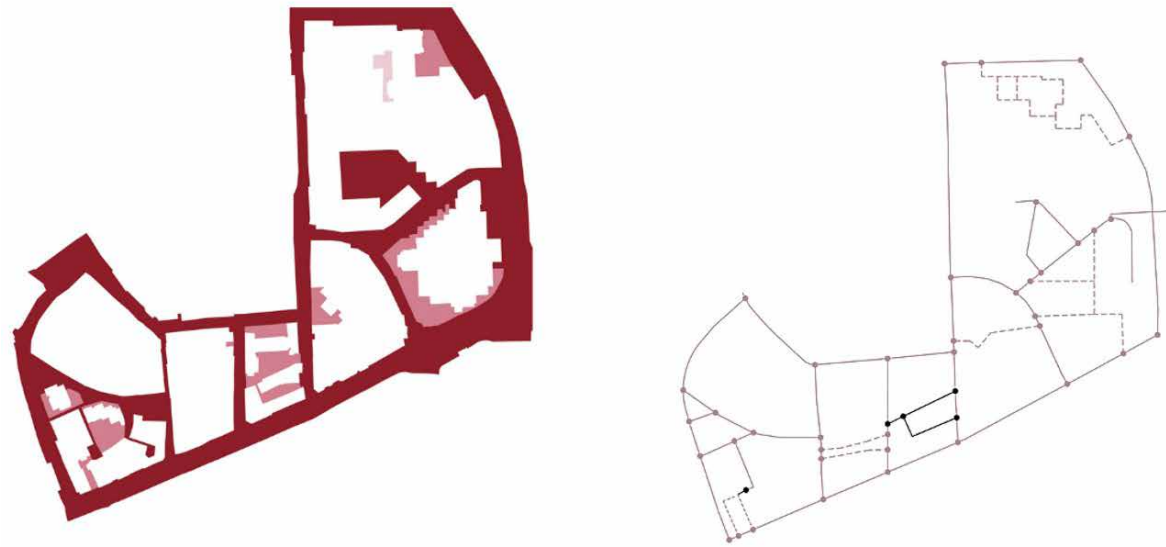


Figure 5. (right) Paths and intersections.

Figure 6. (left) Public space and PPSPA

paths. Connectivity is at the heart of the definition of permeability¹³ given the multiplicity of path options as a condition of responsive environments.

The degree of permeability, in this analysis, varies according to the property associated with it, establishing for this purpose three (3) degrees in ascending order, where number one (1) represents the lowest degree of permeability.

The essential function of in-between spaces lies in three complementary dimensions: a) functional – they expand the pedestrian network by offering additional accesses, path extensions and passages that reduce distances; b) morphotypological – they give porosity to façades, breaking the rigidity of built boundaries and introducing spatial gradations that enrich the urban experience; and c) social – they create opportunities for meeting, staying and interacting, reinforcing community life and the appropriation of space.

Based on the characteristics of the in-between spaces described and the sample under analysis, the cartographic extracts below represent permeable buildings, understood as buildings whose architecture incorporates in-between spaces.

In-between spaces play a central role in the construction of urban permeability, functioning as interfaces between the public and private domains. More than secondary architectural elements, they are devices that activate the built frontage, diversify paths and contribute to the vitality of neighbourhoods.

2.3 Intersections

Defined as the points formed by the crossing of two or more lines, intersections are the meeting point of paths. Paths, whether public or private, increase the options available to pedestrians and reduce distances. The greater the density of intersections, the greater the ability of the pedestrian network to adapt to needs.

14. Carmona, M. et al (2003), p. 42 [Michael Breheny (1992) Evans et al. (2001), URBED (1997)]. In the table of Strategies for the development of a sustainable project, and Matrix of principles for the sustainable project, p. 43 and 44.

15. Idem p.64

Diversity and choice are qualities identified by several authors¹⁴ as an added value of good urban space design in that it offers several options within or across the urban fabric¹⁵.

The analysis of these five blocks is based on the identification of existing walkable axes in public space and in Private Pedestrian Space with Public Access (PPSPA). The nodes resulting from the intersections broaden the spectrum of path options.

The choice of options comes in different forms that can offer different environments: open or closed, public or private, or a combination of these various possibilities. The connections, whether public or private, establish a formal and informal network of alternative paths tailored to the needs, climate and urgency of each person to carry out their activities.

Regarding the concepts presented in this Methodology, it can be said that they form an interdependent system: urban elements provide the structure, in-between spaces introduce porosity and diversity, and intersections multiply options.

Table 1. Numerical data by block and permeable buildings

ID	Structural elements			Area (m ²)	No. of buildings		Number of buildings with at least one type of transition spaces			
	Avenue/ Street	Crossbar	Square		Σ	Permeable	1	2	3	4
BB	6	0	1	55163,00	34	19	15	4	0	0
VB	3	0	0	12743,74	21	11	8	3	0	0
FB	4	0	1	6736,0	6	4	3	1	0	0
GB	4	0	0	8970,93	19	8	4	3	0	1
EB	4	1	1	24759,75	25	6	3	3	0	0
Σ	21	1	3	108373,42	105	48	33	14	0	1
		25								

Table 2. In-between-spaces in buildings

Transition spaces	Recessed entrance	Colonnade	Gallery	Portico	Passage
Representation					
Degree of permeability	1	2	2	3	3
Permeable properties	Accessibility	Continuity	Continuity	Connectivity	Connectivity
Permeability type	Peripheral	Peripheral	Peripheral	Peripheral	Local
No. of buildings	33	13	10	2	6

Table 3. Path length and number of intersections

Id.	Path extension	No. of intersections				Average distance between intersections	
		Publics	ePPSPA	iPPSPA	Σ	Public	Public + PPSPA
BB	1279,77	10	0	6	16	127,98	79,99
VB	503,96	5	0	2	7	100,79	71,99
FB	376,96	4	3	0	7	94,24	53,85
GB	425,57	5	0	4	9	85,11	26,60
EB	976,27	11	0	2	13	88,75	69,73
		35	3	14	52		

ePPSPA – Exterior Private Pedestrian Space with Public Access; iPPSPA – Interior Private Pedestrian Space with Public Access

3. Results

According to Table 1, it can be seen that the structural elements of the blocks under analysis vary in terms of type, number and size, as well as in terms of the degree of permeability of the buildings.

All blocks feature buildings with more than one type of in-between-space, with 48 of the 105 buildings having at least one of these characteristics. This data suggests that permeability is a recurring feature, albeit unevenly distributed across blocks.

Table 2 shows that the most frequent in-between spaces are recessed entrances (33 buildings), followed by colonnades (13) and galleries (10). Although porticos and passageways are less common, their ability to promote continuity and connectivity proves more useful for the pedestrian network than their absolute number. This data indicates that the diversity of in-between spaces plays an important role in terms of properties and degrees of permeability.

Table 3 shows that all blocks have private intersections, either interior or exterior, which expands the formal paths network. Block BB stands out for having the highest total number of intersections, but GB block has the shortest average distance between them, making it the most efficient in terms of connectivity. This contrast demonstrates that the number of intersections does not always coincide with the fact that it suggests path options with shorter distances.

In summary, the quantitative results show that spatial permeability results not only from the presence of in-between spaces, but also from their typology and the articulation between public and private intersections. The comparative analysis between blocks suggests that the effectiveness of the pedestrian network depends both on the number of permeable elements and on how they are organised.

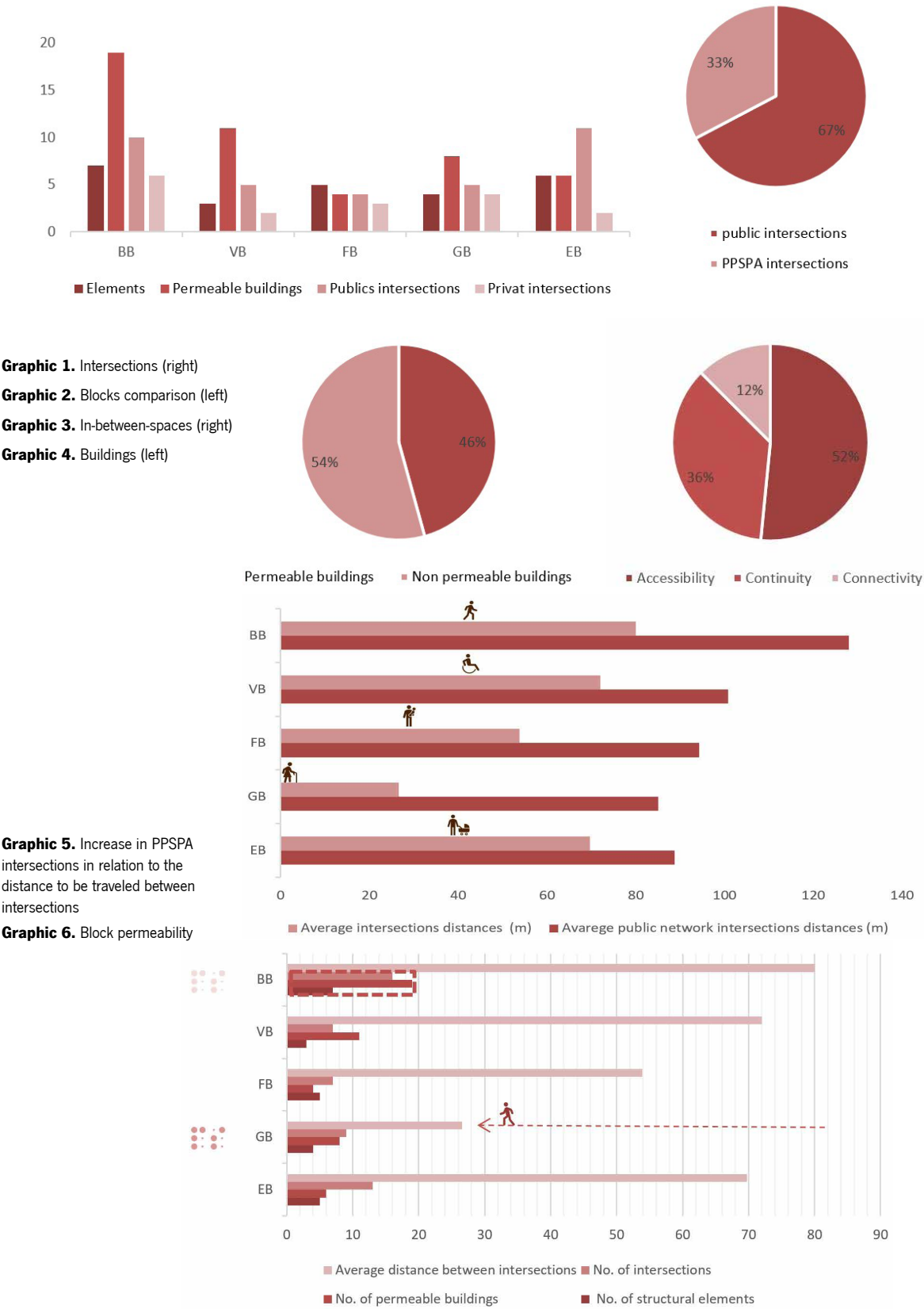
4. Discussion

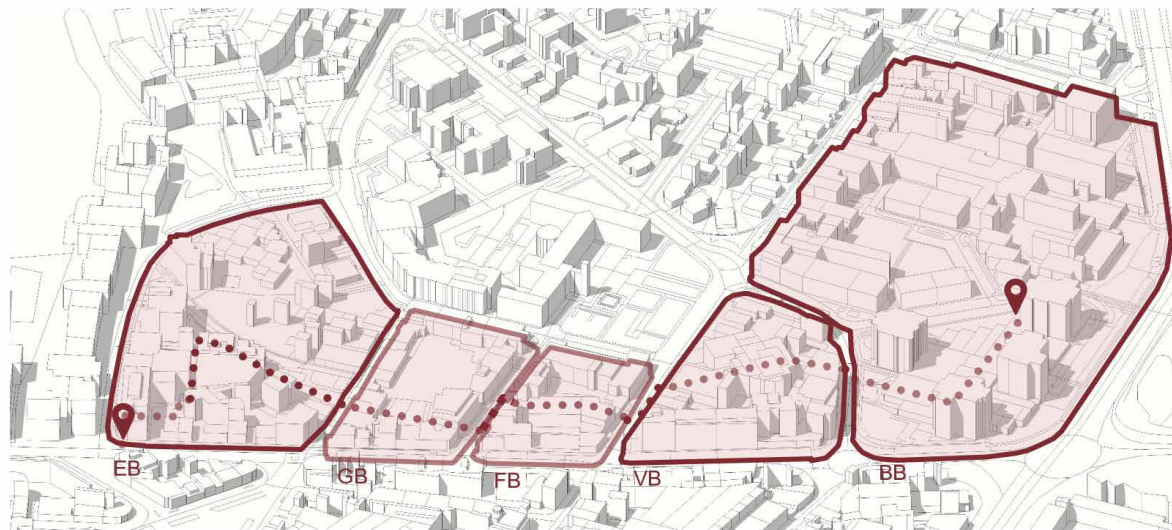
In Graphic 1, the comparison between blocks shows that the number of urban elements and the number of public pedestrian intersections are not related. It also reveals that, although there are a considerable number of buildings with at least one type of transitional space, this data is not correlated with the number of private intersections in public space.

However, in Graphic 3, the sample of buildings with in-between spaces seems significant, given that almost half of the buildings incorporate this type of space into their architecture. In Graphic 2, we see that 1/3 of the intersections originate from paths included in PPSPA, which contributes significantly to the increase in path options.

In addition to offering a greater number of options, public and private intersections contribute to a significant reduction in distances and greater diversity and choice of paths that are better suited to the activity, comfort, time and physical mobility of the individual.

Graphic 5 shows that the more public and private intersections there are, the more likely it





is to reach a destination in less time. This data ensures that, instead of accessibility perimeters, it may be more favourable for pedestrians to choose shorter and more direct paths.

In Graphic 6, in order to identify the block with the highest permeability, the distances between intersections, the number of permeable buildings, the number of intersections, and the number of structural elements were measured. It can be seen that BB block has the highest number of permeable buildings, intersections, and structural elements, but GB block has the shortest distance between intersections. This indicator, the number of intersections, may be the most relevant factor in spatial permeability, as it allows for choices to be made and distances to be shortened.

Figure 1, together with Figure 4 e) and f) and Figures 5 and 6, seems to show a tendency for east-west paths as opposed to the north-south (Braga-Porto) orientation of the road network. This situation may indicate the need to cross extensive urban fronts via alternative paths, given that this condition occurs in all blocks. The crossing paths result from the layout and uses assigned to the buildings on the ground floor. The FB block buildings, but also the existence of first-generation shopping centres in BB, VB and GB blocks, ensure interior passage paths.

A comparison of the five blocks shows that spatial permeability cannot be explained by a single indicator, but by a combination of several factors: in-between spaces, intersections and the length of available paths.

This result reinforces the idea that the quality of the pedestrian network can be measured both by its density and by its ability to shorten paths and offer alternative means of transport. Transitional spaces, such as passageways and galleries, although less numerous, play a key role in the connectivity of the urban fabric.

The implications for urban design are clear: the incorporation of in-between spaces that promote continuity and connectivity can significantly increase the vitality of public space.

Img 1. Example of a continuous path between two points that crosses five blocks through a combination of public and private access



Img 2. Set of local photographs about in-between spaces

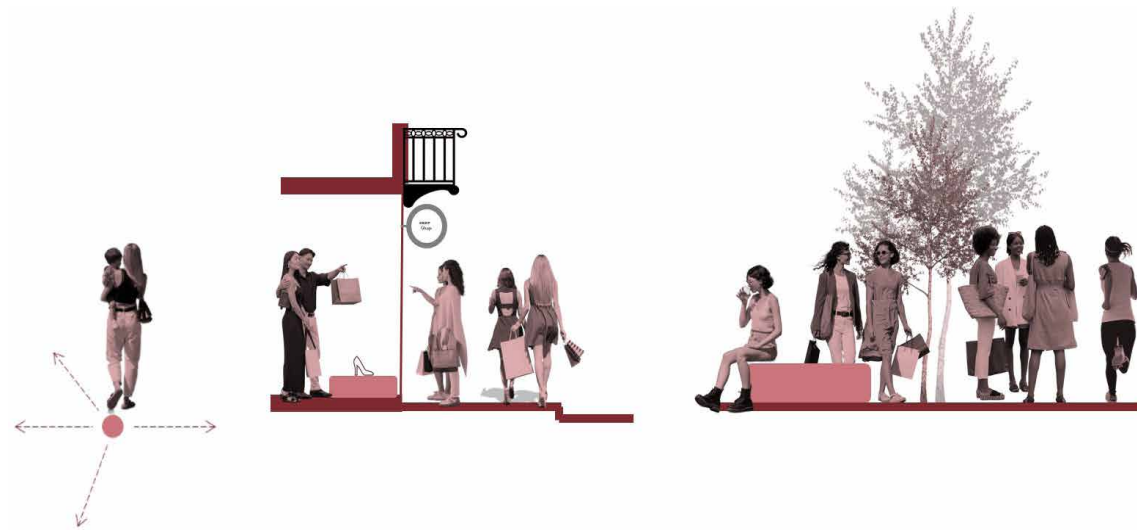
The articulation between formal and informal paths also confirms that the pedestrian network should be understood as a hybrid system, where the contribution of private entities complements the public structure.

Thus, the results are in line with the research objectives, demonstrating how different spatial strategies – from the layout of buildings to the typology of in-between spaces – can influence urban permeability. This analysis also supports the view that urban planning policies and building projects should value the diversity of spaces and promote new paths.

5. Conclusion

In summary, the quantitative spatial analysis of the five blocks selected in the urban centre of Vila Nova de Famalicão revealed the existence of a multifaceted pedestrian permeability system, structured around a primary public network and complemented by informal paths formed by privately owned yet publicly accessible spaces. The application of simple metrics, counts and the identification of buildings with permeable properties allowed us to verify that the sample absorbs the selected concepts.

More than the absolute number of permeable buildings, it was found that the type of in-between spaces (particularly passages and galleries) plays a decisive role in the connectivity of the network. Similarly, the density and distance between intersections proved to be critical factors: while block BB stood out for having the highest number of intersections, it was GB that had the most efficient network in terms of connectivity, showing that the quality of permeability depends not only on the quantity of elements, but also on how they are organised.



On a theoretical level, this approach corroborates and expands on classical concepts of the continuity of public access space, highlighting how recesses and in-between spaces in buildings act as conduits for urban spatial diversity. The articulation between interior and exterior passage spaces confirms the relevance of hybrid planning approaches that simultaneously value topological legibility and morphological richness. Furthermore, this approach validates that spatial permeability results from the articulation between different dimensions - urban and architectural - reinforcing the relevance of in-between spaces as mediators between the public and the private and that spatial permeability can be a strategic factor for sustainability and comfort in urban space.

On a practical level, Img. 2, the results suggest that urban design strategies that promote hybrid, short and diversified paths can contribute to greater vitality and pedestrian comfort, approaching the concepts of walkable cities.

Notwithstanding the quantitative characterisation, there is a recognised need to complement this study with qualitative research, namely through participant observation, user interviews and sensory analyses that explore perceptions of safety, comfort and social appropriation of paths, as well as extending it to other neighbourhoods and comparing it with other similar cases and methodologies. It would also be of interest to analyse other dimensions of urban permeability, Fig. 3, namely visual and experiential permeability, given that the fact that a given context is permeable in terms of path possibility does not mean that it is active or experienced.

However, it can be assured that the integration of mixed methods can facilitate the development of urban policies and design guidelines.

The introduction of criteria that contribute to the enhancement of urban permeability can be applied to the optimisation of the existing network and territories to be structured.

Integrating these different levels of analysis will consolidate a more robust theoretical and methodological framework and enable the formulation of urban planning guidelines aimed at promoting spatial permeability as a strategic condition for the contemporary city.

Img 3. Spatial Permeability // Visual Permeability // Social Permeability

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* MrCutout. People and Trees (Images 2 and 3). MrCutout. <https://mrcutout.com>

TRANSITION

How streets are designed and transformed depends not only on a good balance within the three core dimensions of streets – social, nature, mobility – but also on how the decision-making processes are organised and structured, which is directly related to local spatial planning mechanisms. The following articles give an insight into a broad range of methods, strategic guides and case studies.

By identifying parameters that guide action, both methodologically and strategically, the articles can be seen as a showcase of how design and planning can move beyond fragmented or sectoral approaches. Drawing on manuals and guides, on transition methodologies and exemplary case studies, the articles reveal ongoing dialogues between the social, ecological and mobility dimensions. They expose complex relationships and balances that reflect a mature culture of intervention and planning, one that carefully negotiates the roles and responsibilities assigned to citizens, stakeholders and politically legitimised actors.

The contributions also present policy documents, methodologies and projects that challenge dominant and standardised solutions, which are often confined to a single dimension. In parallel, they demonstrate that transition solutions and street interventions require new ways that go beyond a specific scope, but rather require a critical look at whole processes of urban transformation.

An overview on Sustainable Street Design Indicators: A path for evaluating street transformation

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Abstract

The STREET research project - Street Transformations, Rebalancing Ecology and Environment issues in urban Territories-explores Street transformation projects in Portugal to understand their contribution in sustainable, climate adaptable and ecological urban environments. The interdisciplinary studies on the three key dimensions of street - nature, social and mobility – can clarify in which manner functionality, durability and adaptability is integrated in street design. The research consists of in-depth study on street design and planning components, with the aim to identify sustainability indicators for the development of an evaluation design/planning tool on sustainable street interventions. The STREET research project is organised in two parts: firstly, a literature review on the various indicators on street design (overview publications 50+) and, in sequence, a study case analyses and mapping of 20 recent street projects in Portugal, highlighting each potential sustainable impact (analyses before/after). This paper focus on the first research part.

Since streets are a fundamental component of the public space system, it is assumed that improving existing streets will make a decisive contribution to creating more sustainable urban environments. Within the main challenges of contemporary society and its negative environmental impact, new urban streets interventions play a fundamental role, being essential to rebalance the functioning of public space in urban territories in its social, environmental and mobility components.

This communication/paper focus on overview of the strategic approaches, sustainability indicators and measurement topics for street project evaluation. The framework organises various indicators and potential solutions by three key dimensions of street, based on literature review of: scientific articles, design manuals and guidelines, and public space policy/strategic documents. The research main output will be an objective evaluation tool for assessing the impact on sustainable street transformation. In parallel, it offers also a systematic overview of good practices in street transformation, and an interdisciplinary reflection on the applicability, replicability of various approaches and project principles. The presented results provide a comparable over-view of various sustainable design principles, and the potential reinforcement of social and natural values of streets.

Keywords

Street design, transformation projects, sustainable topics, public space, urban planning.

1. Introduction

The STREET research explores street transformation projects. The in-depth study on design and planning components of streets aims to develop an evaluation tool for assessing sustainability on street interventions in Portugal. As these street projects take place in specific contexts, spatially and governmentally, the aim is to provide a workable and accessible tool to help designers and municipalities improving existing streets. This paper presents the results of the first part of this research, comprising a literature review, enabling us to identify sustainable street design indicators. The next phase of this research will carry out the study case selection and the analyses of 20+ recent street projects in Portugal, highlighting each potential sustainable impact.

The 2030 Agenda for Sustainable Development and its 17 goals, set out the path towards sustainable development by cities and communities (UN, 2015). Public spaces have an important role for environmental regulation, ecology protection and risk management (UN-Habitat, 2015). The design of street influence on liveability, walkability, safety, sociability, environmental impact and productivity of neighbourhoods, enhancing the quality of life, community cohesion and civic identity (ONU-Habitat , 2016). Therefore, improving existing streets can give a decisive contribution to creating more sustainable urban environments.

With the establishment of climate and sustainability agendas and the widening of scope on street design, planning guidelines includes policies more directed to healthy urban environment. Complete streets require a new way to design streets to accommodate all users and modes of transport (Montella et al., 2022), together with the ‘place’ function related to social activities (Zadeh et al., 2022) and more green space (Croeser et al., 2022), providing quality and comfortable public space.

Since the Paris Agreement, the development of Guides, Manuals and Policy Documents follow the European commitment goals, as carbon neutrality, biodiversity protection and social inclusion (Figure 1). Attempting to the global measures, as ‘better ecological livelihoods’ and ‘multimodal and environmentally friendly accessibility’ (Böhme & Gløersen, 2023), the range of manuals and guides, includes implementation measures, design standards and toolkits. Developed by global initiatives, non-profit institutions as well local initiatives, there are also different policies approaches and types of studies. Framing the municipalities, the studies propose strategic lines of action, as green infrastructure (Apur, 2020; Ajunt.Barcelona, 2021) and biodiversity (Ajunt. València, 2022; Berg et al., 2020) and technical guides and design standards (MHCLG London, 2021) (City of Oslo, 2020) (CM Lisboa, 2018). A large spectrum of co-related manuals (Trp.London, 2022) and guides (NACTO, 2016) are specially focused on mobility.

Regarding the implementation, these studies can be supportive of cities staff in a top-down process of street design (City of Oslo, 2022), but also bottom-up reversible approaches on streets and public space transformation (Com. Milano, 2020), implementation (GDCl, 2022) and evaluation (NACTO & GDCl, 2022) promoted by engaged population and stakeholders in general (CrAft, 2024). Instead of design standards, interrelated design principles applied

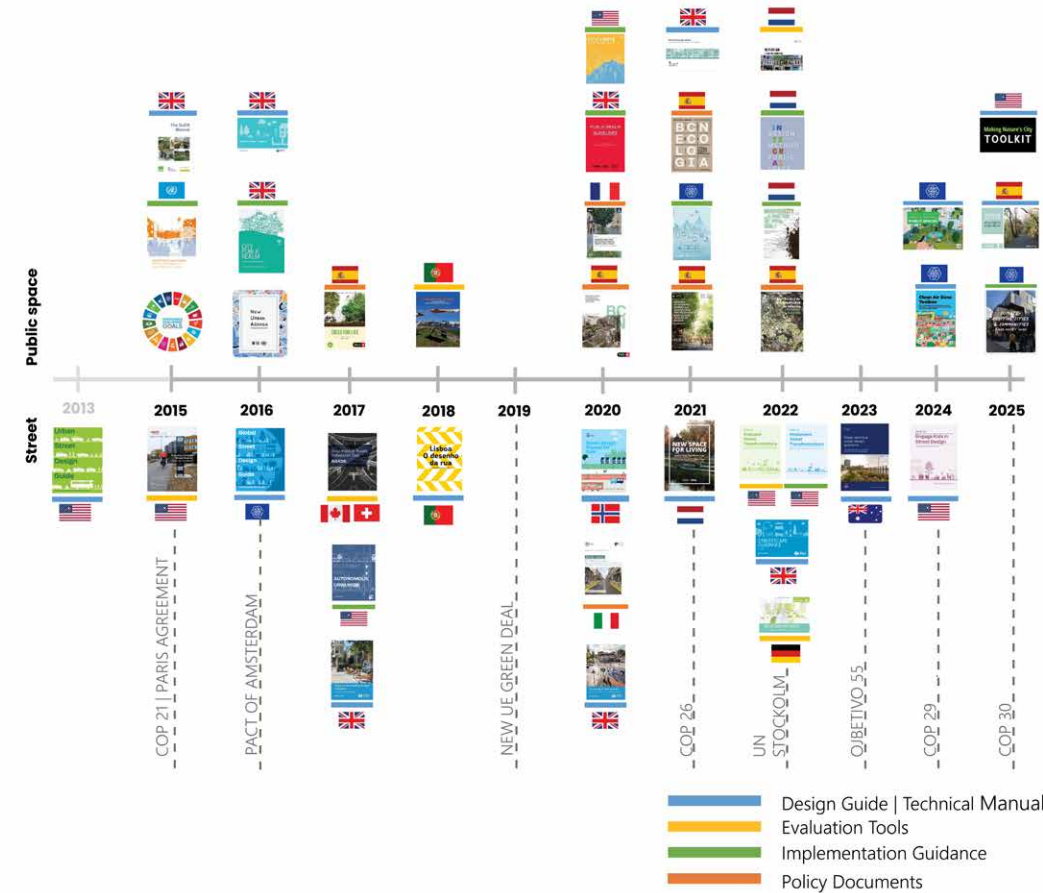


Figure 1. Timeline of the selected Guides, Manuals and Policy Documents, published from 2015-May 2025; Milestones of Climate and Sustainability genda.

to study cases (Groningen municipality, 2021) offers more flexible approach to different contexts (C40 Cities, 2024), inspiring cities and local governments (UN-Habitat, 2015).

2. Methodology

The first phase of this research focuses on sustainable design principles analyses, sustainability indicators and measurement topics for the development of a sustainable street evaluation tool. Therefore, a literature review was carried out, based on design guides and manuals, evaluation toolkits, policy documents and planning instruments developed after the adoption of the Sustainable Development Goals (UN, 2015).

The long-list selection, carried out from January - May 2025, counts on an analyses criteria background and the repository built by the ‘the Future Design of Streets’ platform, less focus on (car)mobility, including more social and natural values into street projects. Therefore, the selected documents reflect the shift in perspective from the traffic engineering to interdisciplinary studies, gathering technical teams with diverse profile, involving urban design, landscape architecture, engineering and environmental study areas. The

geographical and cul-tural dimension is mainly European.

Although, documents developed by NACTO (United States) were included considering its paradigmatic role. Publications from Canada and Australia was also included by its specific con-tribution. The search looked not only at ‘street’ as central research object, but also ‘public space’, ‘public realm’ and ‘city space’. Regarding the promoters, the selection criteria include global initiatives, non-profit institutions, as well local and central authorities.

For supplying accurate indicators criteria, was also a selection criterion the documents that provided specific approaches, focused in the biodiversity enrichment, Nature Based Solutions and walkability, Exclusion criteria included publications restricted to street design for specific contexts.

For this research, 38 publications were selected, being organised in four categories: Design Guides/Technical Manuals, Implementation Guidance, Policy Documents and Evaluation Toolboxes. Firstly, they were analysed to identify the major topics, measures and attributes associated to the improvement of sustainable conditions of street space and their surroundings.

The potential benefits for sustainability were checked on 24 published scientific articles, which evidences are supportive for the design principles and sustainable street design indicators. The search revealed 27 themes that recurrently appeared, which were organized in a matrix (Table 1) that are grouped by the three key dimensions of street (Casas-Valle et al., 2023), namely: nature, social and mobility.

This matrix gives a comparable overview by crossing the identified themes and documents in chronological order, identifying overlaps and gaps between the publications. It also reveals that street design guides and global initiatives tend to cover a wider range of topics, while a qualitative analysis shows depth difference between general and specific approaches.

This systematic framework guided an accurate perception of ‘sustainable streets’, and the path to identify relevant sustainability indicators for the potential reinforcement of social and natural components, rebalancing the dominant impact of mobility in streets.

3. Results

For objective assessment/monitoring of sustainability improvement on streets, measurable criteria are essential. To detect factors that may cause impacts to a sustainable development, the indicators provide quantitative or qualitative measures for performance and conditions, being determinant or suggestive of benefits for sustainability (Journard & Gudmundsson, 2010).

The proposed framework for street sustainability assessment (Table 2) is organised hierarchically (Gil & Duarte, 2013), taking the three key dimensions of streets – nature, social and

Table 1. Overview of Guides, Manuals and Policy Documents (chronological order) crossing the most recurrent topics, organised by the three key-dimensions of streets.

STREET DIMENSION		RECCURENT THEMES																											
		Amenities	Ground floor activity	Accessibility inclusion	Community engagement	Health	Safety	Thermal comfort	Placemaking	Local economy boost	Identity/cultural meaning/A	Social mix Land-use mix	Water	Clean Air	Trees Plants	Soil	Ecology Biodiversity	Construction and material:	Energy	Waste	Walkability/active mobility	Public transport	Shared mobility	Urban logistics	Parking	Traffic calming	Building access	Street network	
YEAR	PUBLICATION	SOCIAL										NATURE							MOBILITY										
2015	UN.H Global Public Space Toolkit	●		●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
2015	Evaluating complete streets projects	●		●	●	●	●	●		●	●		●	●	●	●	●	●	●	●	●			●	●	●		●	
2016	NACTO Global Street Design Guide	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	
2016	SuDS in London - a guide	●			●	●	●	●	●			●	●	●	●	●	●	●	●	●									
2016	London City Public Realm Man+Tlkt	●		●	●		●	●	●		●	●		●	●	●		●		●								●	
2017	Guide to healthy streets indicators	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●		●	●	●	●		●	●	●	●	●	
2017	Masterplan for Barcelona´s Trees			●	●	●	●	●	●	●		●	●	●	●	●	●		●	●				●				●	
2017	Sustainable Asset Valuation Tool					●						●	●	●	●	●	●	●	●	●									
2017	NCT Blueprint Autonomous Urb.	●		●			●					●	●	●	●	●	●		●		●	●	●	●	●	●	●	●	
2018	Lisboa-O desenho da rua	●		●		●	●	●	●			●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	
2018	Lugares do comum: Guia aval. interp.	●	●	●	●		●		●	●	●	●		●	●		●		●		●						●	●	
2020	London Public Realm Guidelines	●		●	●	●	●		●	●	●	●	●	●	●	●	●	●			●			●	●				
2020	Barcelona green infrast. biodiv. plan			●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●					●	●	●	
2020	Street Manual for Oslo	●				●			●	●	●	●		●	●	●	●	●	●	●	●	●		●	●	●	●	●	
2020	The planning for walking toolkit	●			●	●	●	●	●	●	●	●		●	●	●	●	●			●	●	●		●	●	●	●	
2020	City Limits:Setting safe speed limits		●			●	●				●			●			●				●				●	●	●	●	
2020	Strade Aperte-MIL	●		●		●	●		●					●			●				●	●	●	●	●	●		●	
2020	Epaces Publics à Vegetaliser à Paris		●		●	●		●			●	●	●	●	●	●	●		●		●				●	●		●	
2021	New Space for Living NDL	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●		●	●	●		●	●	
2021	National Design Guide (London)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	
2021	A Catalogue NBS Urban Resilience	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
2021	Mesura Govern SuperillaBCN			●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	
2021	BCNecologia:20 years		●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●	●	●	●	
2022	Streetscape guidance-London	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	
2022	How to Implement Street Transf.	●	●	●	●	●	●		●	●	●	●		●			●				●	●		●	●	●	●	●	
2022	How to Evaluate Streets Transf.	●	●	●	●		●		●		●			●			●				●	●	●	●	●	●	●	●	
2022	The Eye Level Game Manual	●	●	●	●				●	●	●	●									●						●		
2022	Integral Design Method Public Space			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
2022	BiodiverCITY: A matter of vital soil			●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●				●	●	●	●	●	
2022	DL Bluegreen Streets	●				●	●	●	●	●	●		●	●	●	●	●	●	●	●	●				●	●	●	●	
2022	Plan Verde y Biodiversidad Valencia			●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●				●		
2023	Water sensitive urban design guide				●	●	●	●				●		●	●	●	●								●				
2024	NACTO Kids in Street	●	●	●	●	●	●	●		●	●	●	●	●	●				●	●	●	●			●	●			
2024	C40-Design Guide green & thriving	●	●	●	●	●	●	●		●	●			●			●	●	●	●	●	●			●	●	●	●	
2024	C40 Cities-Clear air zone toolbox	●	●	●	●	●	●	●		●		●	●	●	●		●		●	●	●	●	●	●	●	●	●	●	
2025	NEB Climate Positive Cities			●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●				●	●			
2025	Making Nature´s City Toolkit	●				●	●	●				●	●	●	●	●	●		●							●		●	
2025	Paisaxe Galega:Guía de Boas Práticas	●		●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●				●	●			

mobility – as central themes. The following analyses categories - Water and Air; Plants & Soil; Construction Technologies & Materials; Activities; Ground Floor and Active & Collective Mobility - organizes the sustainability indicators and measurement topics. However, indicators may have multiple effects upon one another, with impact chains and interactions (Lutzkendorf & Baloutktsi, 2017). For the development of the sustainable street evaluation tool, the core indicators described below addresses environmental issues, namely climate change, loss of biodiversity and the depletion of natural resources, pursuing sustainable goals.

3.1 Nature

Water management is directly related to flood mitigation, thermal comfort and biodiversity enrichment. Its good performance meets the Water Framework Directive targets (EP & CEU, 2000), beyond fostering equity, community engagement and placemaking (NACTO, 2017). The combination between porous pavement and vegetation increases evotranspiration values, reducing surfaces temperature and heat island effects (Eckart, J. et al. 2022). The Sustainable urban drainage systems - SuDS (Mayor of London, 2016) or Green Stormwater Infrastructure – GSI (NACTO, 2017) and its components can be a measurement criteria of water management (Mayor of London, 2016).

Green coverage benefits to health, well-being and climate change is sustained by several studies (Konijnendijk, 2021), including cooling, flood risk reduction and urban biodiversity support (Croeser et al., 2024). Trees gives identity to streets, making them kinder and enjoyable (Ajunt. València, 2022). Urban canopy provides social and landscape services (Ajunt. Barcelona, 2017), fostering communal and physical activities (C40 Cities, 2024). The many benefits for human wellbeing (Croeser et al., 2024) can be assessed by minimal standards using the 3-30-300 rule for equitable access to green on streets and public spaces (Konijnendijk, 2021). More space for green coverage can come from parking spots, road space, green roofs and facades (C40 Cities, 2024).

Biodiversity in urban areas delivers a wide range of ecosystem services and human well-being by interacting with nature (Garrard, et al., 2021). Its enrichment indicators are related to water and the connections between green and soil networks. The main strategies focus on the nature-inclusive design to provide healthy soil (Berg et al., 2021); and articulating and connecting green spaces by tree-lined streets, including density and quality of green parameters and minimal standards of permeable surfaces (Ajunt. València, 2022).

Land use impact and Resource efficiency: Urban environment plays central role on climate resilience and heat effect islands. Surface material’s properties, as permeability, colour and heat absorption/reflectivity, can greatly affect the outdoor comfort (City of London Corporation, 2024). Materials and construction techniques must minimize the carbon footprint and life-cycle impact (Be First, 2020), providing circular economy (Xunta de Galicia , 2020) and assuring ethical sources (City of London Corporation, 2024). The combination

STREET DIMENSIONS	ANALYSES CATEGORIES	CORE INDICATORS	SUPPLEMENTARY INDICATORS	MEASUREMENT TOPICS	
NATURE	WATER & AIR	Water management	Permeability of soil	Water retention	
			Storm water NBS	Water quantity management	
	PLANTS & SOIL	Trees & Biodiversity		Density of trees	
				Quality of trees	
				Planting bed	
				Green surface	
				Green network	
				Green diversity	
	CONSTRUCTION TECHNIQUES & MATERIALS	Efficient use of resources	Materials impact	Life-cycle	
				Construction techniques	
				Heat effect reduction	
			Energy and Waste	Renewal energy/consumption	
SOCIAL	ACTIVITIES	Street activity		Waste	
			Diversity of uses	Meet & stay facilities	
				Leisure and recreational facilities	
				Programme related activity	
				Social events	
			Active frontage	Outdoor use	
	GROUND FLOOR	Built Environment quality	Street physical features	Buildings function	
				Building preservation	
				Spacial / functional continuity of street	
				Street furniture, facilities	
				Lighting	
				Hybrid zone	
Cultural meaning			Materials, objects, monuments		
			Ancient trees		
			Built heritage		
			Street art		
MOBILITY	ACTIVE & COLLECTIVE MOBILITY	Urban Depht		Facades openings	
				Permeability	
				Stoop use	
			Amenities	Stop & rest places	
				Bins	
				Bicycle parking	
			Accessibility	Barriers	
				Ramps	
				Tactile pavement	
			Comfort space	Pedestrian area/space coexistence	
				Cycling area/space coexistence	
				Quality of pavement	
			Safety	Crossings	
				Signage	
				Street network/road accessibility	
				Proximity to cycle network	
			Transport diversity		Proximity/connectivity to public transport
					Charging stations
	Shared mobility options				
Traffic management		Clean air zones			
		Speed reduction			
		Parking management			
		Traffic calming devices			
		Loading zones			
		Clean means of transport			

Table 2. Proposed framework for street sustainability assessment: key dimensions, analyses categories; core and supplementary indicators, and measurement topics.

of 'cool' and high-emissivity paving materials with vegetation can also lead to impressive improvements to the microclimate of streets (Cortês et al., 2016).

3.2 Social

The built environment for its morphological analyses is fundamentally defined by three physical elements: buildings, plots and streets/public space (Moudon, 1997). Its relationship with the biophysical system, produces a complex living landscape, bridging the natural, social and cultural in the public space (Santos et al., 2025). The built environment contributes with the elements that define the street space beyond infrastructural features - as pavement and streetlights - representing the condition of the street as a place (Monteys, 2010). The relation between the street and the vertical architectural elements – or the street interface between public and private space – affects the liveability of street (Al Mushayt et al., 2021). The built environment quality is related to physical features (as street proportion, furniture / street elements and historic buildings) and the sense of safety, comfort and level of interest of a street, with direct impact on the walking behaviour (Ewing & Handy, 2009). The street on the 'eye level' - facades character, the openings rhythm, building typology and active entrances - affects use and quality of streets (Stipo, 2020). The appropriation of the 'hybrid zone', with clothes lines, pots and statues for example, expand the domestic space, bringing the house closer to the street and promoting the 'at home' feeling (Monteys, 2010). The street character promotes cultural identity and authentic sense of place, enhancing community engagement (Hassen & Kaufman, 2016). Protecting the built heritage, historical context and traditional materials are supportive measures (Groningen municipality, 2021). Street art reinforce the identity of public space and the collective memory, adding cultural significance and economic vitality (CM Lisboa, 2018). Ancient trees are also a heritage to be restored, valorised and strengthened (Apur, 2020).

Street activity: Many definitions of social sustainability consider community engagement and economic equity as the main determinant factors (Bafarasat & Oliveira, 2022) and streets can potentially foster (or hazard) this outcome (Hassen & Kaufman, 2016). Streets form the basis of public space, and the way it is organised, provides various social functions, including space for flows, meet and stay (Casas-Valle et al., 2023). Liveability is a complex and subjective concept related to comfort, quality life and sense of belonging (C40 Cities, 2024). Therefore, healthy and inclusive places of social proximity require the overlapping of measures and attributes, as: green spaces, accessibility, diversity, walkability, safety and traffic calming (Hassen & Kaufman, 2016). The diversity of activities and functions incorporating daily rhythms, especially on the ground floor, can make street more alive and vibrant, playing important role for the walking experience (Casas-Valle. et al., 2023). As the green & blue infrastructure and thermal comfort are directly related (Eckart et al., 2023), trees, green facades and water improves the quality of stay in the street (Bauer et al., 2022), supporting social engagement outdoors (Tamminga et al., 2020).

Urban Depth is the depth of streets beyond the facades, considering the permeability or

porosity of the built system, which derives from the arrangement of spaces, cells, and entrances (Casas-Valle et al., 2023). The quality and functionality of each street depends on a balanced relationship between the public space of the street itself and the organisation of private space (Casas-Valle et al., 2023). Permeable and accessible configurations, as doors, windows and semi-public spaces, influence pedestrians' visual interaction with street interface, creating soft edges between private and public spaces (Mushayt et al., 2021). The buildings openings as the 'eyes on the street' (Jacobs, 1961), considering windows within a distance of 43 m from the streets and up to the first floor of the buildings, can improve actual and perceived safety in urban spaces (van Asten, 2023. p. 221).

3.3 Mobility

Traffic management is essential for reducing the number of vehicles on the road, improving human health (Fenger, 1999) and road safety, encouraging active mobility (European Commission, 2013a). To achieve climate neutrality by 2050 (EC, 2019) and reverse negative impacts of car-centred mobility. Sustainable Urban Mobility Plans - SUMPs (EC, 2013a) guides the development and integration of all transport modes. Implementing clean air zones (C40 Cities, 2024), speed limits and parking management (NACTO, 2020) promotes peaceful traffic and healthier (TfL, 2017) inclusive movement (C40 Cities, 2024). Reducing space for vehicles creates more space for active mobility and green areas, as the Superblock Model propose, improves the environment, liveability and health (Nieuwenhuijsen et al., 2024).

The Active mobility provides undoubted health and well-being benefits enhancing physical activity (Mueller et al., 2015) and economic activity (Sevtzok, 2020), community engagement and social cohesion (Hassen & Kaufman, 2016). The prioritization of active mobility by low speed and car free urban units and green space promotes more comfortable and safer environments, fostering interaction between neighbours (Nieuwenhuijsen et al., 2024). Walkability and cyclability are influenced by objective factors - as accessibility, comfort space and street connectiveness (NACTO, 2016) - and subjective factors - as urban design qualities and individual reactions (Ewing R., Handy S., 2009). The assessment shall include features and qualities of social and natural environment (Sustrans, 2021), as street space and ground floor activity, the green infrastructure (Magrinyà et al., 2023) and thermal comfort (Cortês et al., 2016). Amenities, like benches and lighting, are indispensable, providing safe spaces to stop and rest (NACTO, 2022).

Transport diversity creates complementarity that suits people's individual mobility needs, reducing competition between different forms of transport and car dependence. (Rupprecht Consult, 2019). Efficient collective mobility is necessary when proximity-based accessibility is not possible, being an indicator for equity and inclusivity (Mouratidis, 2024). Efficient mode share options, as electric cars, scooters and bicycles, plays important role offering convenient and clean option for the last mile travel. (Rupprecht Consult, 2019).

Freight efficiency produces as a more friendly urban logistics, economical effectiveness,

ecological rationality and social relevance (Pulawska & Starowicz, 2014). The indicator can be assessed by the transition to means of transport (as cargo bikes, train and river transport) and e-vehicles, educational measures and time schedule for loading/unloading (IMMT, 2011). Automation of urban freight with responsible policies can be a future solution for dense urban areas, by its reduced size and deliveries based on destination, managing also flexible curb side and schedule for last-mile delivery (NACTO, 2017).

4. Conclusion

This paper presents, as a first part of the STREET research, an overview on ‘good practices and strategies’ behind design principles on street design, disseminated by a range of Guidelines, Manuals and Policy Documents. It highlights a survey on indicators of an objective assessment criteria for street transformations, pointing measurable attributes that can contribute for sustainable, climate adaptable and ecological urban environments. The recognised indicators and measurement topics were supported by scientific sources and data, showing its potential benefits. It reveals that some outcomes - as social inclusion, community engagement, walkability and ground floor activity - are influenced by both objective and subjective factors.

The results from the first part of this research project provide the foundation for the next step: establishing applicable measurement criteria by identifying specific values for assessing attributes and related indicators. While the research has outlined an initial analytical framework for recognising measurable attributes, subsequent work will refine and expand this dimension, translating it into an operational level applicable to street design projects (urban context, street section, etc.). In the next phase, 20–25 case studies will be selected across several Portuguese municipalities. The objective is to develop a tool for designers and planners to understand and enhance the sustainable impact of street transformation projects. The tool will be tested, calibrated, and improved through the assessment of recent street transformation projects in Portugal, considering the solutions, strategies, and design components, highlighting each potential sustainable impact through the before-and-after analysis of the design and planning elements of the transformations.

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Citizen Engagement and Socio-Cultural Transformation in the development of a Walkable City in Braga

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Abstract

The Municipality of Braga has approved the Sustainable Urban Mobility Plan (SUMP) in 2023, taking a proactive approach on the need to support the physical and social transformations of the territory within a strategic and broader perspective of the new paradigms of sustainable mobility.

In pursuit of the goals set for the walkable city, and acting extensively in the qualification of a wide network of pedestrian routes, the “Eu Já Passo aqui!” (“I Can’t Get Through!”), and “Areas +” programmes were implemented in the city of Braga with the main purpose of humanising the public space, providing a continuous universal pedestrian infrastructure articulated with the other modes of transport, capable of generating different dynamics in pedestrian movements.

Beyond technical and urban management challenges, the projects addressed socio-cultural tensions regarding the use and appropriation of public space. This emphasized the need to (re)think the methods of citizen participation and involvement in the planning and implementation of sustainable mobility policies. The methodologies that have been adopted in the context of the dynamics of co-creation and empowerment of the population in the case of Braga stand out for their focus on learning and the integration of socio-cultural and physical components.

In this paper, and by presenting the more recent projects developed within the scope of the Mobility Department, we will explain some of the strategies that have been adopted in this regard. The case of the Avenida da Liberdade project,

flagship intervention of the Program “Eu Já Passo Aqui!”, will be the subject of more in-depth reflection, not only because of its recognised importance as a prominent public space in the city, but also because it is an example of the potential of citizen engagement during the construction phase. From a socio-cultural transformation perspective, this example becomes more than just a project.

Keywords

Citizen engagement, social innovation, participatory governance, mobility justice

1. Introduction

Being a historic city, whose foundation dates back the Roman Empire, Braga faces important challenges in the matter of the urban design. The ensemble that encompasses the medieval area embodies a very dense and consolidated network of buildings, public spaces and streets of narrow section, while the outskirts have a very car-orientated urban design.

The municipality's efforts to promote pedestrian mobility is being carried out consistently since the beginning of the 1990s. Through the development of strategies and public investment, over 60 streets and squares have been refurbished, corresponding to more than 200,000m² of pedestrianised area in the city center. This practice has made a decisive contribution to the rehabilitation of buildings, improving urban living and socialization, as well as fostering the development of commercial activity.

Despite the municipality's efforts to establish a predominantly pedestrianised area within its medieval core, this multifunctional space still features an urban layout that occasionally disrupts pedestrian flow, with interruptions caused by vehicular streets and various physical obstacles. The high number of parking spaces and car parks, the need to monitor vehicle access to the area, and the challenge of shifting mindsets and behaviours are among the key issues that must be addressed.

The Sustainable Urban Mobility Plan (SUMP), though not formally approved until 2023, established a clear and strong commitment, setting decisive principles at this level. The core principles of the SUMP for the Municipality of Braga are the promotion of sustainability, i.e. the balance between the economic, environmental and social values, and also the quality of the urban environment and territorial cohesion. In order to achieve this vision, tangible actions were listed, aimed at transport systems and their infrastructures and services, and intangible actions, oriented towards strengthening a culture of mobility based on raising awareness and training for behavioural change. In line with the National Strategy for Active Pedestrian Mobility it was considered fundamental, first and foremost, to favour pedestrian transport, promoting sociability, the local and traditional economy, making it the primary mode of transport for all citizens.

As part of efforts to strengthen pedestrian mobility, actions were planned to enhance the walkability in public spaces, promoting principles of pedestrian-friendly circulation, universal accessibility, and safety throughout the urban environment. The proposal for the city center focuses on creating systems of uninterrupted continuity, prioritizing pedestrians as the main and preferred mode of transportation. The street is viewed not only as a transit space but also as a place to stay and socialize. The aim is to consolidate a cohesive pedestrian mobility system that is not fragmented or dispersed. A space that promotes sociability and is multifunctional, bringing together commercial activities, services and facilities.

The Programs “Eu Já Passo Aqui!” and “Áreas +” represent concrete operationalisations of the principles set out in the SUMP. These interventions aim not only to requalify urban space by prioritising pedestrian infrastructure, but also to stimulate behavioural change and foster

inclusive civic engagement. The redevelopment of Avenida da Liberdade, flagship project of the Program “Eu Já Passo Aqui!” and Braga's most central north-south urban axis, stands out as both a physical and symbolic transformation. Within this context the individualist rhetoric ends up emphasising the need to (re)think the methods of citizen participation and involvement in the planning and implementation of sustainable mobility policies.

This paper analyses the methodological framework underpinning these interventions, critically examining how co-creation and citizen empowerment have been applied to support both infrastructural change and socio-cultural transformation. The research adopts a qualitative case study methodology, combining urban analysis with policy review and participatory observation. Data sources include: official planning documents (e.g. SUMP, SECAP, PMOT); technical reports from the Municipality of Braga; observational studies and photographic documentation of intervention sites; public consultations and participatory budget assemblies; semi-structured interviews with citizens, municipal staff and civic organisations.

The analytical framework is informed by the mobility justice literature (Martens, 2016; Sheller, 2018) and transition management theory (Corais et al., 2022; Loorbach, 2010; Nevens et al., 2013), which allow for a critical understanding of how physical infrastructure and socio-political processes intersect.

2. Case Studies

2.1. The “Áreas +” Programme (2018-2020)

“Área +” is a programme of architectural interventions in public space designed to shift the prevailing urban mobility paradigm in Braga, aligning with the city's broader urban rehabilitation strategy. It focuses on four strategically selected areas identified as particularly critical in terms of accessibility and urban quality: Montelios, Praça das Fontainhas, Praceta João Beltrão, and Praça do Bocage. Each presented severe challenges related to pedestrian connectivity, architectural barriers, and degraded public amenities. Through tactical interventions, the programme sought to eliminate physical barriers, implement 30 km/h zones, prioritise pedestrian continuity, and reframe neighbourhood blocks as community-centric units. Guided by principles akin to urban acupuncture (Corais et al., 2022), the initiative aims to reallocate space that had long prioritised car traffic. It inverts the traditional mobility hierarchy by placing pedestrians at the centre, promoting safer and more equitable access to the city. Simultaneously, it addresses accident reduction, while enhancing local green infrastructure and public amenities to improve overall urban liveability.

Public involvement played a decisive role in the design phase, with open consultation sessions in each neighbourhood. While some areas lacked formal civic associations, local networks were activated to gather resident feedback. In Montelios, a residents' association even delivered a formal specification booklet that informed final design choices (Pereira et al., 2021).

According to official evaluations, the interventions was expected to reduce 179.48 tonnes of

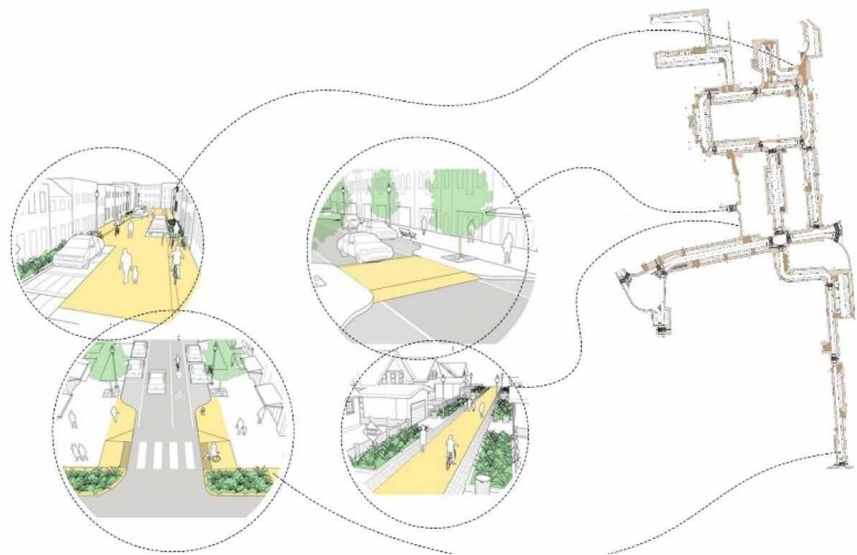


Figure 2. Typology of interventions planned under the “Areas+” initiative. Source: Municipality of Braga, Mobility Department.

CO₂ per year and significantly enhance active mobility options for vulnerable populations. But their real achievement lies in re-framing the public space as a place of community, interaction, and urban identity.

2.2. The “Eu já Passo Aqui!” Programme (July 2022 – ongoing)

Originally proposed under the Participatory Budget process as “Eu Não Passo Aqui!” (“I Can’t Get Through!”), this programme emerged as a direct response to the daily experiences of exclusion and inaccessibility reported by people with reduced mobility. Its renaming to “Eu Já Passo Aqui!” symbolised both physical and symbolic transformation.

Key intervention zones include Avenida da Liberdade, Avenida António Palha, Rua António Mariz, S. Lázaro, Parque Radical, and the surroundings of EB1 Maximinos school. These areas were selected for their high pedestrian and softmobility potential, critical urban connections, and proximity to schools, commercial zones, green spaces, and public transport. The project covers a total of 57,945 m² of public space and 6.8 km of pedestrian and soft mobility routes. The primary aim of this programme is to eliminate architectural barriers and ensure continuous, obstacle-free, universally accessible pedestrian routes; guarantee pedestrian safety and autonomy through raised crossings, improved lighting, smart traffic systems, and inclusive street infrastructure; promote inclusive design, integrating tactile paving, auditory signals, tactile guide paths to meet the diverse needs of users; enhance connectivity and accessibility by linking key city areas through accessible, continuous, and comfortable walking and cycling routes; reduce car dependency and its environmental, social, and public health impacts by prioritising active and sustainable mobility; foster procedural and recognition justice through bottom-up processes, ensuring that decisions reflect the needs and experiences of the community.

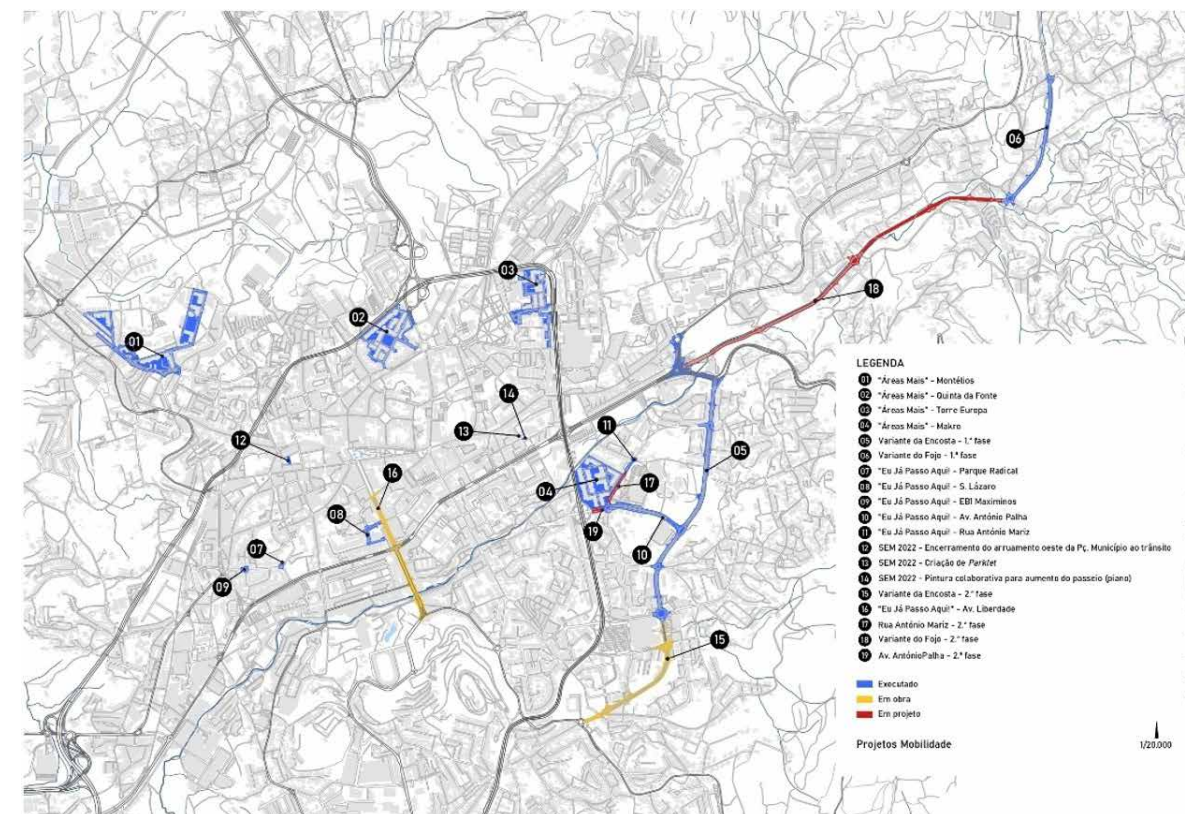


Figure 1. Location of the areas intervened in under the initiatives “Eu Já Passo Aqui!” and “Áreas+”. Source: Municipality of Braga, Mobility Department.

A total of 3,178 m² of new accessible pedestrian areas were created under this programme, including podotac-tile paving, tactile guide paths, auditory signals, smart traffic lights, and lighting at pedestrian scale. These features support autonomous and dignified movement for persons with disabilities, the elderly, children, and other vulnerable groups. Estimated reduction of 827 tonnes of CO₂ per year (about 2,250 kg/day) through the promotion of walking, cycling, and improved public spaces.

From a governance perspective, the project’s participatory origins were complemented by inclusive engagement mechanisms during the implementation phase —such as on-site information kiosks and regular dialogue with organisations like APD (Association of People with Disabilities) and ACAPO (Association of the Blind and Visually Impaired).

2.2.1. The “Avenida da Liberdade” project

Avenida da Liberdade is Braga’s primary urban corridor, linking the northern and southern sectors of the city centre. With high symbolic value and strategic connectivity, it was chosen as the flagship intervention for the “Eu Já Passo Aqui!” programme. The intervention required approximately 30,105 m², with 437 m² of new accessible pedestrian space, from the Rotunda de S. João to the intersection with Rua do Raio. The project included the re-profiling of the road in order to introduce the concepts described above and reformulate mobility patterns. In addition to widening the sidewalks and narrowing the traffic lanes



Figure 3. Avenida da Liberdade.
Source: Municipality of Braga,
Mobility Department.

in order to reduce speeds, one-way cycle lanes were inserted. New pedestrian crossings with podotactile flooring were introduced, inter-sections were improved, barriers to inclusive circulation and underpasses were eliminated. All the furniture, street lighting, signage and other infrastructures have been duly revised. The interfaces with public transport and future BRT (Bus Rapid Transport) stops were improved. The intervention on this axis has greatly benefited the soft-mode connectivity of the entire city center and pedestrian area, as well as the conditions for universal accessibility.

Importantly, this intervention served as a living lab for inclusive urbanism, where the presence of a permanent information stand allowed for continuous feedback, dispute mediation, and civic education throughout the construction phase. Transparent public engagement through consultations and the on-site information stand, ensured accessible, inclusive, and ongoing communication for All citizens.

3. Citizen Engagement, Participatory Governance and Socio-Cultural Transformation

Braga's approach exemplifies a paradigm shift from top-down planning towards a model anchored in participatory governance, socio-cultural reflexivity, and procedural justice. Rather than perceiving people as passive beneficiaries of expert-driven interventions, the Municipality of Braga has increasingly recognised citizens as co-producers of urban change.

The "Eu Já Passo Aqui!" programme emerged through the participatory budget mechanism—an institutional innovation designed to democratise the prioritisation of municipal



Figure 4. Information Stand placed at the construction site of Avenida da Liberdade during the construction phase. Source: Municipality of Braga, Mobility Department.

investment. Importantly, this was not simply a financial redistribution tool, but a procedural gateway that allowed underrepresented groups, particularly persons with reduced mobility and their advocates, to place urgent accessibility issues on the municipal agenda. This mechanism exemplifies how democratic engagement can shift institutional priorities in favour of mobility justice (Corais et al., 2022; Martens, 2016).

Participation in Braga did not end with the identification of priorities. The planning and execution of interventions, namely in projects such as Avenida da Liberdade, integrated dynamic feedback between residents, stakeholders and municipal technicians. The information stand placed during the construction works and the direct coordination with civil society organisations, such as APD (Portuguese Association of Disabled People) and ACAPO (Association of the Blind and Visually Impaired of Portugal), enabled ongoing negotiation and adaptation. These practices reinforce the notion that meaningful participation is continuous, multi-scalar, and co-evolving—a process aligned with transition management theory (Loorbach, 2010; Nevens et al., 2013).

Notably, Avenida da Liberdade became a socio-spatial laboratory for testing inclusive planning methodologies in real time. Here, pedestrianisation triggered a range of responses: while many citizens supported the transformation of the space into a dignified and accessible civic boulevard, others—particularly car-users and commercial actors—resisted the perceived loss of car access and parking. The Municipality's capacity to manage these conflicts with transparency and technical legitimacy was key to consolidating institutional trust and sustaining the transition. In this sense, pedestrian infrastructure was not only a technical deliverable, but a platform for redefining urban citizenship and the right to the city (Banister, 2008; Pereira et al., 2021).

In the "Áreas +" programme, interventions in high-density residential zones relied on direct community involvement, particularly in Montelios, where a residents' association played an active role in shaping project goals and monitoring implementation. In areas lacking formal associations, the municipality developed alternative outreach strategies, such as outdoor weekend assemblies in public space. These methods demonstrated a capacity to adapt participation to context-specific realities, recognising that engagement must accommodate both formal and informal civic structures (Pereira et al., 2021).



Figure 5. Co-creation activities developed under the scope of the Just Streets project in School André Soares. Source: Municipality of Braga, Mobility Department.

These participatory processes are deeply intertwined with a broader socio-cultural transformation in Braga's urban governance. Mobility has served as a vector for addressing structural inequalities—such as the spatial exclusion of older adults, people with disabilities, and lower-income residents—by embedding inclusivity and equity into urban design standards. Furthermore, the Municipality has begun integrating these participatory planning practices into its institutional routines through capacity-building within technical departments. This includes incorporating accessibility criteria in all street design projects, aligning mobility initiatives with the Municipal Social Charter, and expanding the remit of the Mobility Advisory Council. These efforts reflect a growing institutional commitment to embedding social policies (e.g. disability rights, intergenerational inclusion) within the core of technical planning, thus ensuring policy coherence and systemic resilience.

The alignment of these practices with European priorities, such as the Urban Agenda for the EU, the New Leipzig Charter, and the Sustainable Development Goals, reinforces Braga's positioning within a transnational movement toward equitable and sustainable urbanism. Participation in EU-funded initiatives such as JUST STREETS¹ and STEP-UP² provides additional platforms for methodological refinement, peer learning, and international dissemination. These projects are particularly important in this context, bridging the gap between theory and action, providing practitioners with the knowledge and tools necessary to embed justice more systematically into street transformation strategies, and ultimately contributing to long-term systemic change in urban planning practices.

4. Conclusions

The transformation of urban mobility in Braga, driven by the integrated implementation of the “Eu Já Passo Aqui!” and “Áreas +” projects within the strategic framework of the Sustainable Urban Mobility Plan (SUMP), illustrates a profound paradigm shift in how cities can address accessibility, public space justice, and citizen participation. These interventions are far more than infrastructural upgrades; they represent a deliberate repositioning of pedestrians as central actors in the urban realm, reversing decades of car-oriented planning

and redistributing space in favour of inclusive and sustainable urban life.

What makes these initiatives distinctive is the way they embed social justice, accessibility, and citizen participation at the very core of urban mobility planning—an approach still rare at the municipal level in Portugal. Through an “urban acupuncture” strategy, small but high-impact interventions were implemented across key public spaces, producing citywide improvements without major infrastructural disruption. This approach proved particularly effective in historic, dense areas, where targeted and highly visible actions generated systemic impact. Importantly, the process was socially inclusive—anchored in co-creation through Braga's Participatory Budget, public consultations, and a permanent on-site information stand—ensuring transparent and accessible engagement, even for those without digital access. Technologically, the systematic application of universal design enhanced safety, comfort, and accessibility for all citizens.

The lessons from this experience highlight the critical importance of participatory governance, long-term vision, and institutional adaptability. They demonstrate how local governments can operationalise the right to the city by embedding inclusivity into both processes and outcomes. As Braga advances toward a more sustainable and equitable mobility system, it is preparing to strengthen its monitoring capacity through citizen surveys, usage data, and qualitative testimonies, in order to assess the social, mobility, and climate benefits of these interventions over time. Future initiatives should consolidate these principles while deepening post-project evaluation, long-term monitoring, and regional cooperation within European city networks.

By embracing co-creation, universal design, and socio-cultural awareness as integral components of mobility policy, Braga is not only advancing its own transition but also positioning itself as a leading European reference in the practical realisation of the right to the city.

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Streets as spaces for people, urban nature and mobility: analysis of programs and interventions in Barcelona, Antwerp and Lisbon.

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Abstract

Drawing on European case studies, this study, part of ongoing PhD research, examines the interaction between urban planning and street-level interventions in reshaping street environments.

In response to growing discourse about the urban city's transition processes and the transformations of streets, cities are developing plans and programmes that aim to acknowledge these latest developments towards a new form of planning that reclaims a living public space, where everyday life and biodiversity are ensured, beyond mobility (Pagh & Cook, 2023).

Urban programs like “Let's protect the schools” from Barcelona, “Uma Praça em Cada Bairro” in Lisbon or “Garden Streets” from Antwerp have introduced new planning paradigms to address these challenges. These initiatives prioritise alternative uses of public space, integrate ecological systems, and promote climate-adaptable street designs, offering new tools for urban planning.

By examining the premises and implementation of these programmes, the study acknowledges a comprehensive notion of what a street represents - beyond mobility – to include green, social and equitable transport spaces (Banister, 2011). Accordingly, three key dimensions are used to analyse the method of each case study: social spaces, urban nature, and mobility (Casas-Valle et al, 2023).

Integrated into a systemic implementation, the case studies share concepts of proximity and centrality regarding the contexts of intervention and the programmes they address. A representative intervention from each programme is analysed to identify emerging urban design strategies, spatial configurations and approaches to street design.

Considering that, also examines how programmes are an important operational tool and how street-level interventions encompass multifunctional and flexible solutions that interdependently address each of the dimensions studied. It also reflects on how these dimensions are being adjusted and prioritised according to their context and programmes, while considering the pressing challenges of sustainability and the paradigm shift in mobility.

Keywords

Community activation, social design, urban transformation, neighbourhood engagement, sustainable development, participatory planning, environmental justice

Introduction

In Europe, there has been a growing discourse on the transition and the transformation of streets. Sustained by the sustainability studies (Alberti, 2023), and then, more recently European funding, particularly the SUMPS - Sustainable Mobility Programmes - which are in line with the SDGs (2015), or the Paris Agreement (2015) (Fig.1), the pressures and urgencies that COVID-19 has brought to the public space, determine the commitment to new policies and visions for each city.

Considering these commitments and the discourse of sustainable urban planning (Alberti, 2023; Koch et al, p.15), that unwittingly shape urban planning and even the execution of various projects, to mitigate environmental impacts and improve the quality of urban life (Montella, et al., 2022; Totaforti, 2020; Bendiks & Degros, 2019) a paradigm shift is demanded as plea to rebalance the place of the street.

To achieve these principles, it is necessary to question the car-centred model that has conditioned city planning for the last century and its pedestrian landscape (Ghel, 2017) and that currently represents several constraints as safety levels, the discomfort caused by the polluted, atmospheric and noisy environment, as well as the absence of public space in some areas (Pagh & Cook, 2023). This inherent infrastructure related to car traffic created a hostile environment for a broad spectrum of the population, of different ages, sociocultural backgrounds, and people with limited mobility (Banister, 2011), which now requires a transformation that involves a gesture that strengthens the use of active modes, such as walking and cycling (Koch, Rudder, & Signer, 2024). In this regard, the reallocation of spaces for such activities must focus on the street design and planning.

In the context of urban transformation, Ascher (2010) and Smets (2021) point out that projects for cities are not based on construction plans, but rather on the redesign and alteration of street conditions.

Recent proposals for interventions focus on the street as a fundamental way of rethinking the city, giving rise to local and neighbourhood solutions that are potentially fairer and more equitable.

Even though Anguelovski (2018) and Hasse (2017) may question the latter - equity and justice - concerning these latest transformations, the street is above all a democratic place and incorporates in itself one of the first accesses to public space, for circulation and interaction (Borja & Muxí, 2003; Sim, 2019).

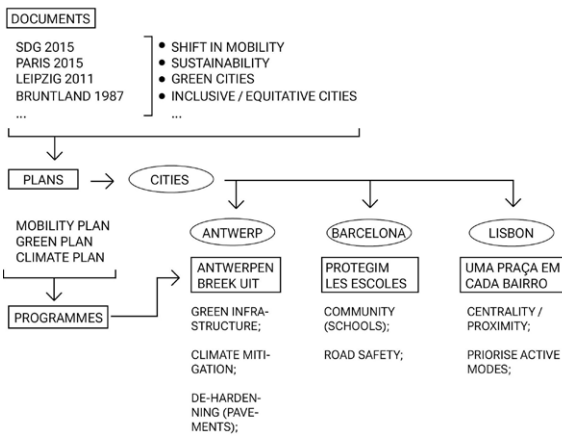
As a complex environment, the street is also a place of diverse daily interactions and spontaneity, which requires a sense of agency, belonging and identity (Sim, 2019; Serena & Hauderowicz, 2020), demonstrating its potential as a catalyst for social interaction and community space.

Streets are yet fundamental for the challenges regarding the ecological systems. While incorporating passive features to address challenges related to climate impact, tackling overheating (3°C Neighbourhood, 2024), and the risk of overflow (Furchtlehner , Lehner ,

& Lička, 2022). These same features can enhance biodiversity preservation and resource flows, like water management.

Beyond addressing technical issues specific to public space infrastructures, these solutions also have the potential to enhance users’ comfort and health (Healthy Streets). Simultaneously, they play a fundamental role in recognising and taking responsibility for nature and bringing people closer to it, which is known as biophilia, that “is the affinity humans have to connect with nature” Sim, 2019 (Totaforti, 2020); (Cabanek, de Baro , & Newman , 2020).

Figure 1. Overview of discourse and plans of the case study cities



Research

Recognising the evolving role of streets in contemporary urban planning and the paradigm shift they embody, this study examines the planning frameworks of three European cities, that are intending to achieving that same political agenda,—Lisbon, Barcelona, and Antwerp—to analyse their programmes and the corresponding representative street interventions implemented, namely Largo de São Sebastião da Pedreira, Carrer de Provença, and Lange Ridderstraat (Fig. 1)

By acknowledging the complex ways in which the street facilitates alternative forms of mobility and introduces ecosystems, it investigates the underlying premises and discourses of each urban context, while also identifying the design features adopted and the potential and emerging spatial typologies and their planning approaches.

This research, through the lens of architecture and urban planning, observes in depth the examples that illustrate the transformation of streets, with particular focus, on case studies implemented within municipal programmes. This is the starting point for the analysis: understanding the relationship between each case city’s overarching urban planning, their programmes, and the street-level interventions. The analysis of municipal programmes and their main premises concerns: Uma Praça em Cada Bairro (2014), Protegim les Escoles (2019) and Tuinstraten (2017).

Goals, Methodology and Case Studies

To develop a broader understanding of these systemic programs and interventions, the aim is to examine the case studies, their objectives, discourses and the modes of intervention, through a summarised scheme and the first table (Fig.1;Fig. 2), and review the city plan based on accessible data, literature review, semi-structured interviews, comparing all of them, and organising by topics.

Ascher (2010) asserts a basic notion of the street, mentioning that it is defined for ‘traffic, service and accommodation’. In this sense, the article analyses case studies that challenge and support this foundation, based on the new meanings of the street and the response to alternative/pressing planning paradigms, advocating a more equitable ‘redistribution of traffic space’ (Bendiks & Degros, 2019), and proposing an observation based on three dimensions: social, urban nature and mobility.

The latter consider several principles established by Casas-Valle et al (2023), among others, visions such as the Free the Streets Manifesto (2023), Healthy Streets and the Groningen Plan (2021), which address measurable principles and characteristics that street space can provide and reflect on how each characteristic, typology and design is addressed in each project.

The articulation of the concepts, together with the delineation of the three dimensions, constitutes a coherent framework for the systematic examination of street design (Fig.3). When integrated with the interpretive analysis of the on-site photographic material (Figs.4, 5 and 6), this framework permits the classification of each surveyed element, design grammar and spatial solution that is associated within social, urban nature and mobility dimension.

Results

The strategic frameworks of these case studies and its city programmes are grounded in plans focused on ecological approaches, active modes of mobility, and the creation of

	ANTWERP	BARCELONA	LISBON
PLANS / STRATEGIC DOCUMENTS	Green Plan (2013) Water Plan (2019) Climate Plan 2030 (2020)	Network Model Planning for Mobility (2013-2018) Climate Plan 2018 - 2030 (2018)	Lisbon Pedestrian Accessibility Plan (2014) Support Manual for Public Space Design and Construction - Lisbon, The design of the street
PROGRAMMES	'Antwerpen Breekt Uit' (2017 - ongoing) Antwerpen Breaks Out	'Proteгим les Escoles' (2019-2023) Let's Protect the Schools	'Uma Praça em Cada Bairro' (2014 - ongoing) A space in every neighbourhood
PROJECTS	Tuinstraten - Garden Streets (2017)	'Proteгим les Escoles' (2019-2023)	'Uma Praça em Cada Bairro' plan (2014 - ongoing)
MODE OF INTERVENTION	- Structural intervention (Pilot test);	- Tactical intervention;	- Structural intervention;
DISCOURSE	- "Pleasant streets and squares that provide cooling, more greenery and water." - restoring the water cycle; - 'de-hardenning' - removing sealed surfaces; - more space for greening; "	- Road Safety , regarding heavy traffic street, noise and pollution; - shifting mobility paradigm involving communities (scholar one);	- Defining a new centrality for the neighbourhood defining a new centrality for the neighbourhood; - Prioritise pedestrian continuity and living spaces; - Space redefinition within structural intervention;
ACTORS INVOLVED	City of Antwerp in collaboration with Flemish Department of Environment, Water-link and Aquafin (water agencies)	City of Barcelona: Mobility Department; Department of Strategy	City of Lisbon: Public Space Department (created in 2015) and subcontracting

Figure 2. Brief description of each city's plans and programmes from the analysed case studies.

Figure 3. Observation analysis and description of each feature and relevant aspects of each street, based on the dimension framework – social, urban nature, mobility.

	Lange Ridderstraat	Carrer de Provença (Escuela Entença)	Largo de São Sebastião da Pedreira
	Antwerp	Barcelona	Lisbon
YEAR	2021	2021	2024
AREA	1282 m²	2748 m² (aprox.)	13.900 m²
EXTENSION	191.35 m	(unspecified)	(unspecified)
SECTION	6.85 m	19 m	17 / 35 m
PROJECT	City of Antwerp	Municipality of Barcelona	Municipality of Lisbon
TEAM	Collaboration with Flemish Department of Environment; Water-link and Aquafin (water agencies);	Urban Strategy Services Directorate; Furnish Carnet;	Public Space Department / Municipality of Lisbon (general coordination); Hipólito Bettencourt (Landscape Architect); SRU; Tecnovia;
DESIGN			
DESIGN PRINCIPLES	- Relation with the built environment (building and street) as support for the whole intervention; - Strucutral intervention through design and innovative materials;	- delimitation of an area of the street that is protected and its transformation of the uses of public spaces; - Improving road safety; - Space organisation through planters, diversified equipments and painting;	- Structural intervention and coherent integration with the urban fabric and buildings; - Special attention for the pedestrian movement (continuity of pavements);
MODE OF INTERVENTION	- Structural intervention (Pilot test)	- Tactical intervention	- Structural intervention
TYPOLGY	- Residential street	- School Street	- Neighbourhood Street
3 DIMENSIONS			
SOCIAL			
Soft Edges	- Buffer zones between circulation area from the houses; - Front gardens that enhance interaction;	- Canopies for comfort and protection through shading screens at the school entrance;	- Open area to provide different activities - multipurpose area;
Inviting/Meeting places	- Places to seat (informal)		- Backrest seats (along walking routes); - Installation of a terrace kiosk; - Trees shadows;
Multifunctional / Diverse places		- Different places to stay through lightweight types of equipment/furniture, and materials; - Equipment that invites to play;	
URBAN NATURE			
Blue infrastructure/ Porosity	- Water infiltration through porous pavements; - Buffering sub-foundation with porous infiltration pipes and water-permeable paving or planting areas; - Water from rooftops is reused for		
Green infrastructure	- Implementation of trees when it's possible; - Vertical gardens, pocket gardens/ front gardens, shrubs, trees;	- Planters - potted flowers (yellow - to be recognisable as the school street);	- Implementation of new trees; - Preservation of the existing ones; - Creating new green areas for shrubs and flower beds;
Biophilic design / Biodiversity	- Installation of insect houses;		
MOBILITY			
Traffic calming measures	- Chicane design lined with flower beds and spaces for shrubs;	- Local network street: maximum speed 20 km/h; - Surrounding area of 30km/h (Carrer d'Entença); - Traffic calming measures, adopting curb extensions - xamfer and sidewalk enlargement- , berlin cushions; - Created gateway through obstacles; traffic light regulation;	- 30 km/h implementation; - Surrounding coexistence street;
Acessible , appealing footpaths	- Comfortable footpath;	- Curb extension to provide space for people to walk and other activities by: - Sidewalk enlargment; - Xamfer enlargement;	- Priorising pedestrian movement by continuous pavement; - Smooth pendant;
Shifting Priorities / Diverse modes	- Shared Street, prioritising walkability;		- Priorising walkability;

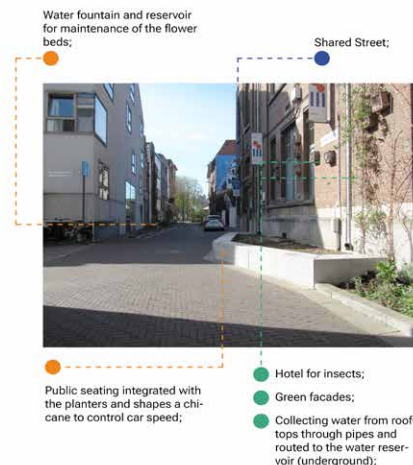
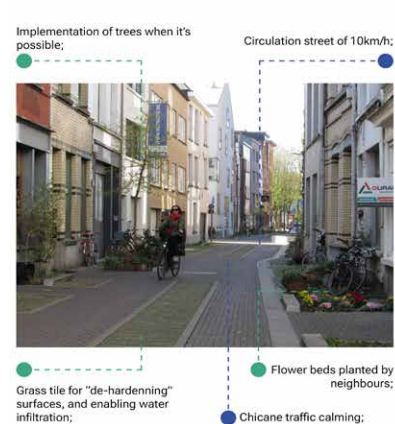


Figure 4. Analysis and description of each feature and relevant aspects through observation on site – Lange Ridderstraat, Antwerp.



Figure 5. Analysis and description of each feature and relevant aspects through observation on site – Carrer de Provença, Barcelona.



Figure 6. Analysis and description of each feature and relevant aspects through observation on site – Largo de São Sebastião da Pedreira, Lisboa.

places that promote community and proximity, as comprehended in the Discourse in Figure 2. Each project, driven by these programmes, seeks to articulate dimensions such as mobility in interdependence with other dimensions that can be affected by the street space, calling for a rebalancing of uses that promotes safe spaces for encounters and other activities, and the integration of innovative ecosystems.

The following results are obtained from a cross-sectional reading of the presented framework and on-site observation (Fig. 4,5,6).

This allows for a comprehensive and informed assessment of the constituent elements and conceptual grounds of this recent street transformation practices.

1.The program and project as a systemic change.

Von Schonfeld et al. (2017) emphasise that the current city transitions question the 'modernistic planning' while adapting cities more systematically. The relevant aspect is how the systemic change regime, by adopting a programme and implementing it, can respond to pressing challenges and encourage behavioural change (Banister, 2011).

In this regard, given diverse environmental and behavioural demands, each programme's scope and implementation strategies vary significantly: Antwerp is conducting a pilot initiative to scale it to the entire Flemish region, beginning with 15 designated "Garden Streets", while Barcelona has extended its interventions across the municipality area, successfully establishing 223 "School Streets". Lisbon, on the other hand, is focusing on 30 strategically selected centralities, aiming to ensure that all residents have access to these spaces within a 500-meter radius (Figure 2 and Figure 7).

2. Each programme defines public-space objectives through its own discourse.

Beginning with the scope of these interventions and their corresponding programmes, and considering the various modes of intervention, Alberti (2023) highlights that, within the context of urban transformation and regeneration, the outcomes of these interventions vary significantly, encompassing structural approaches to more tactical strategies.

Antwerp, with a strong emphasis on infrastructural approaches, prioritises blue and green solutions and engages in processes of "de-hardening" by replacing sealed surfaces with permeable materials. Similarly oriented toward structural interventions, Lisbon focuses on transforming uncharacterised car-centric spaces into more cohesive urban environments aligned with the existing urban fabric. These two cases exemplify long-term, infrastructural strategies. In contrast, Barcelona adopts a more tactical and expansive approach, aiming to intervene in nearly all schools within the metropolitan area. Justified by its broad intervention in the school streets program (comprising 223 of the 585 schools surveyed), Barcelona's strategy is grounded in tactical urbanism principles: using fewer resources, enabling quick implementation, and maintaining cost-effectiveness.



Figure 7. Map of interventions within the municipality area of each city: 01. Antwerp - 15 Garden streets (Tuinstraten); 02. Barcelona - 223 school streets from 585 selected; 03. Lisbon - 30 squares/ spaces from 150 places identified.

3. Experimenting with innovative approaches.

Each program's principles are subsequently adapted to the specific conditions of each selected street or area, often structured around a pre-established toolkit that guides both the implementation process and the selection of physical elements.

These street-level interventions, along with their broader programme frameworks, embody a sense of experimentation (Bertolini, 2020) - not only in their spatial organisation and design strategies but also in the composition of the involved stakeholders, enhancing the urban governance discussed more recently (Loorbach, Frantzeskaki, & Hu, 2024; Ascher, 2010). (Figure 2)

Antwerp, for instance, implements its program through specialised interdisciplinary teams while simultaneously promoting resident participation in both the design and long-term maintenance of public space.

4. The plans respond to a mobility paradigm shift, redefining spaces and street typologies.

Regarding these street interventions, each program recognises the necessity of adapting its strategies to the specific context and spatial characteristics of the location. Barcelona operates at a metropolitan scale and builds upon a pre-existing framework of mobility plans (30, 20, 10 km/h) that had already established speed regulations and intervention typologies as a tool to apply. An illustrative example is Carrer Provença, where two of the four typologies initially defined in the program—sidewalk enlargement and chamfer—have been applied to enhance pedestrian accessibility and spatial coherence.

Exploring the articulation in several nodes of the city, Lisbon intends to revitalise several streets that converge in this centrality. The same is applied to Largo de São Sebastião da Pedreira and the surrounding streets, where the program applies for traffic calming measures and limits to car traffic.

The Antwerp programme focuses on residential areas with fewer mobility challenges. Implementing context-sensitive measures that prioritise other modes of mobility, traffic calming measures, and enhance spaces for residents.

The key characteristics of these interventions are presented through diagrams and summaries, as illustrated in Figure 3, 4, 5 and 6.

5. Street interventions embody multidimensional concepts, new design strategies and components.

Beyond adaptations specific to the street and its immediate surroundings, many other tools are applied that give the space another type of use and provide its fluidity, bringing new toolkits and logics of space reallocation (Ghel, 2017; Koch, Rudder, & Signer, 2024). These concepts are represented and illustrated across certain dimensions, and depicted in Figures 4, 5, and 6.

These solutions demonstrate, for instance, how the school street program's capacity to explore and leverage its inherent elasticity and adaptability (Serena & Hauderowicz, 2020; Sim, 2019), in the context of traffic design layout. (Fig. 4, 5 and 6).

This layout features mentioned above can be tested in Barcelona, and in the case of traffic calming measures, that simultaneously provide living spaces. Curb extensions through the sidewalk, such as chicanes and gateways (Global Designing Cities Initiative, 2016) together with strategies like speed reduction, these are some of the implementations. Similar approaches are applied in the basic chicane typology in Lange Ridderstraat.

On the same versatile and multifunctional approach, yet more restrained, Lisbon employees design tools that encourage the use and accommodation of social activities, through its elements as backrest seats and paved open areas. This ensures a balanced and utilitarian spatial configuration, optimising the overall functionality and usability of the area. The materials and their robustness, in both cases, are considered fundamental elements for exploiting these characteristics and turning these spaces into vibrant, lived public spaces.

The adaptability of the space in Lange Ridderstraat reflects a structural and innovative transformation of this residential street, centred on the integration of ecological systems through the implementation of green and blue infrastructure. For instance, regarding urban nature, Lange Ridderstraat emphasises a design that considers urban elements that are more water-sensitive, incorporating features such as flower beds that facilitate rainwater infiltration and serve as buffers for rainwater runoff from roofs.

Through these design elements, like flowerbeds in front of the house, as a buffer area, or playful elements as the water fountain, the program Tuinstraten embodies the leverage for this sense of experimentation that enables the motivations for residents to take care of their space, as agent of maintenance, but also enhances how an intervention like this can combine nature-oriented literacy and how it can benefit the environment (Totaforti, 2020).

6. Projects assign varying weights to these dimensions.

According to the table in Fig. 3, the components and solutions assigned to each dimension vary according to the priorities of each project. In Antwerp, there is a concern to integrate various solutions related to the urban environment; Lisbon comprehensively addresses all dimensions; and Barcelona defines its spatial solutions based on mobility-oriented measures.

Discussion & Conclusions

The transformation observed in these three cities is guided by their distinct programmes, each reflecting a comprehensive and ambitious action plan. While these plans are necessarily specific to the city and its mode of implementation, they collectively aim to achieve systemic change through operational and pragmatic strategies. Although this operationalisation is a relevant lever as an instrument of transformation, this observation is not intended to assess the effectiveness or success of the transformations, but rather to analyse briefly how they were carried out and to understand the elements and gestures applied to the project.

Furthermore, although based on only three case studies, they capture recent urban transformations aligned with the main objectives of the European agenda.

The frameworks present a systematic analysis of the programmes and interventions surveyed, with results that corroborate other instruments and agents of change, as well as being supported by a combination of regulatory frameworks, predefined intervention strategies, and toolkits for articulation through spatial design.

The implementation of the programmes is understood as strategic and communicative, promoting street improvements, encouraging new types of behaviour for a different way of experiencing public space, especially addressed in the principles of proximity or centrality in Antwerp and Lisbon or the strengthening of a community in Barcelona.

In addition to understanding the programmes, our analysis of the streets suggests that the response to change on the streets, not only addresses the dimension of mobility but also calls for interdependence with other dimensions, adding further layers of complexity and encompassing multifunctional logic present in the street layout. These principles translate into more flexible spaces, since they must relate to each other, and into informal solutions, and determine other ways of planning and designing, which above all prioritise public space, which goes beyond traffic space.

In conclusion, the way these solutions are analysed contributes to ideas and a systemic view of municipal programmes. While adapted to the specific principles of each programme, the solutions and tools used are pragmatic and multifaceted, contributing to reflecting on the transferability of these insights in other contexts, considering the urgency of the debate on sustainability and the call for a paradigm shift in mobility.

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Gender-Sensitive Street Design in Oaxaca: Transitioning to Inclusive Urban Spaces

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Abstract

This paper explores the transition from car-dominated planning to gender-inclusive street design through the lens of the Oaxaca Historic Center Pedestrianization Project (OHCPP), a large-scale intervention currently in development. While initially framed around walkability and heritage preservation, the project evolved into a site of participatory negotiation—where women, caregivers, and marginalized residents raised critical issues around safety, caregiving mobilities, and visibility in public space.

Using a feminist urbanism lens, the paper develops a four-part gender-responsive design framework comprising: (1) gender-inclusive design principles, (2) gender-sensitive interventions, (3) gender-responsive planning processes, and (4) continuous feedback loops. This framework is applied post-hoc to assess the OHCPP's five proposed street typologies and their capacity to meaningfully respond to gendered urban exclusion.

Findings reveal both progress and limitations. Typologies such as pedestrian-priority streets integrate key features—lighting, rest areas, and spatial continuity—aligned with feminist principles. However, other typologies remain ambiguous or insufficiently inclusive, particularly in cycling and mixed-use zones. The absence of typological guidance for peripheral or informal neighborhoods further underscores the risk of spatial selectivity under progressive discourse.

Crucially, the OHCPP exemplifies a planning culture in transition. It reflects how gender considerations can be integrated through civic engagement, lived experience, and iterative design—even in the absence of a formal equity mandate within the planning system. While legal frameworks addressing gender-based violence do exist in Mexico—such as state-level strategies and national legislation—they remain largely detached from the spatial and procedural logics of urban design. As such, the project also illustrates the limitations of symbolic inclusion when institutional commitment, planning mandates, and structural accountability are not in place.

This case contributes to broader debates on the future of street design by demonstrating that transitions toward equity require more than spatial change—they demand a reconfiguration of planning values, design cultures, and power relations in the production of public space.

Keywords

Gender-Inclusive planning, feminist urbanism, pedestrianization, spatial justice, civic design

1. Introduction

Urban streets are often described as democratic spaces—open to all, inherently public, and shared by default. Yet their design tells a different story. For decades, street planning has privileged efficiency, flow, and control—particularly the movement of private vehicles—over equity, care, and social life (Kern, 2020; Greed, 1994). These priorities are not ideologically neutral; they reflect a planning culture that continues to marginalize those whose mobilities are seen as secondary, unpredictable, or inconvenient. Among them: women, caregivers, children, the elderly, and gender-diverse individuals (Beebeejaun, 2017; Madariaga & Roberts, 2013).

In Latin America, these exclusions are especially entrenched, amplified by colonial legacies, classed geographies, and gendered power relations in urban life (Falú, 2010; Sandercock & Forsyth, 1992). Despite progressive legal instruments and increasing attention to equity in policy discourse, the built environment still reproduces disparities in safety, accessibility, and visibility. Women’s routes tend to be longer, more fragmented, and shaped by fear; caregivers navigate sidewalks with strollers and uncertainty, often in spaces that ignore their needs; and gender-diverse individuals face heightened surveillance and vulnerability in public space (Pain, 1997; Koskela, 1999; Kern, 2020).

These concerns are not merely theoretical. In contexts like Oaxaca, where planning frameworks remain underdeveloped and institutional fragmentation persists, the lived experience of public space continues to reflect structural exclusions. Although national and state-level legislation has attempted to address gender-based violence, recent reports indicate that such violence remains persistent—revealing the limits of legal reform when spatial conditions remain unchanged (CEMPAG, 2024). These patterns are not isolated social phenomena; they have material and spatial consequences that define who can safely move, linger, and belong in the urban environment (Whitzman et al., 2013).

This paper emerges from a design and research process in Oaxaca, Mexico, where a pedestrianization project in the historic center unintentionally created the conditions for a different kind of conversation. What began as a technical intervention—focused on traffic reduction and walkability—soon became a site of contestation and negotiation around who streets are for, and under what terms. Community workshops, spatial critique, and practical constraints surfaced questions that conventional mobility planning often leaves aside: Where do people rest? Who avoids the space at night? Who uses streets not just to move, but to care, wait, or stay?

While the project was not initially framed through a gender lens, it generated—through friction and reflection—a set of concerns, tensions, and design responses that gradually pushed it toward a more inclusive logic. Building on this experience, the paper proposes a post-hoc framework that articulates how street transformations can become gender-responsive in practice. The framework comprises four interdependent components: (1) Gender-Inclusive Design Principles, (2) Gender-Sensitive Design Interventions, (3) Gender-Responsive Planning Processes, and (4) Typological Applications across different street conditions.

Each of these elements reflects a shift—not only in spatial form, but in design culture, planning priorities, and political recognition. In this sense, Oaxaca becomes more than a case study; it becomes a site of transition—from mobility-dominated approaches to more plural, situated, and justice-oriented frameworks. The argument is not that Oaxaca has “solved” gender in street design. Rather, it offers a grounded example of how shifts can begin—imperfectly, contingently, and under pressure—and how they might be used to ask better questions about the futures we are designing for.

2. Theoretical Framework

2.1 Streets as Gendered Infrastructure

Despite the increasing prominence of equity within global policy frameworks—most notably the Sustainable Development Goals (United Nations (UN), 2015)—gender remains under-addressed in the spatial practices of street design. Planning norms continue to prioritize circulation, control, and mobility efficiency, while the differentiated ways people use and experience streets remain marginal. Feminist urban theorists have long asserted that the built environment, far from being neutral, is a material expression of power relations (Valentine, 1990; Kern, 2020). The street, both as a spatial and social element, is no exception.

Planning cultures tend to assume a default user: a cisgender, able-bodied, time-sovereign man in transit. This imaginary erases a wide range of lived realities—particularly those of women, caregivers, and gender-diverse individuals, whose mobilities are shaped by care responsibilities, safety considerations, and time poverty (Sandercock & Forsyth, 1992; Greed, 1994; Beebeejaun, 2017). These oversights are not incidental; they are systemic, shaping what is possible in everyday urban life. In Latin American cities, these exclusions are further intensified by spatial inequality, fragmented citizenship, and entrenched gender norms.

2.2 Geographies of Fear: Violence and Urban Design

One of the most visible consequences of gender-blind design is the spatialisation of fear. Pain’s (1997) concept of “geographies of fear” helps explain how experiences of harassment and threat become internalised and mapped onto the city. Women and gender-diverse people often avoid specific streets, intersections, or times of day—not only because of direct experiences of violence, but also due to ambient cues: poor lighting, obstructed sightlines, lack of seating, or isolation.

This fear is not irrational—it is structural. It is embedded in the design, maintenance, and governance of space, and reinforced by absence: the absence of gender-disaggregated data, of care infrastructure, of participatory processes that center diverse needs. Crucially, it disproportionately affects those whose mere presence in public defies dominant norms.

These design omissions are not simply technical—they are political decisions about who is expected, who is welcome, and who must assess the risks of showing up.

For gender-diverse individuals, visibility often becomes a condition of vulnerability. In what Foucault (1977) might describe as disciplinary space, the urban environment itself polices bodies through exposure. Benches, crossings, storefronts, and plazas are not merely passive infrastructure but participate in a regime of control over who can occupy space, and for how long.

What is often framed as an emotional or irrational reaction—fear of walking alone, avoiding certain places—is, in Lefebvre’s (1991) terms, a spatialised effect of social production. Fear is not merely a private feeling but a consequence of political and material design decisions that regulate access, visibility, and legitimacy.

The right to the street, therefore, becomes contingent—negotiated through invisible, daily risk assessments (Whitzman et al., 2013; Koskela, 1999). Feminist urbanists argue that unless this fear is addressed both materially and procedurally, public space cannot be meaningfully inclusive (Kern, 2020). Until governance and design reflect the full spectrum of those who inhabit the city—not only as users, but as knowledge holders—public space will remain structured by silence, absence, and the invisible labor of navigating risk.

2.3 Mobilities of Care: Reclaiming Everyday Movement

Care work represents another axis of exclusion in mobility planning. Unlike the linear commute assumed by most transportation models, caregiving mobilities are cyclical, fragmented, and contextually bound. Women and caregivers frequently engage in trip chaining—combining school drop-offs, errands, and elder care—across a patchwork of disconnected and often hostile environments (De Madariaga & Roberts, 2013).

The implications for design are immediate. Elements such as benches, safe crossings, shade, tactile paving, and rest areas are not mere amenities but preconditions for equitable access. When these are lacking, they create what Magaloni (2019) calls the “pink tax”: the additional cost—in time, money, and effort—that women pay to navigate the city. As Falú (2010) has shown, this manifests as a territorial expression of inequality, in which the design of space reinforces unequal distributions of time, exposure, and burden.

In Latin American cities, where social safety nets are often weak or absent, caregiving is not simply a routine—it is a survival infrastructure. Women and community networks compensate for institutional shortcomings through embodied, often invisible labor. This transforms care into an urban infrastructure that is vital, yet unfunded and unrecognized.

Designing gender-responsive streets thus requires acknowledging what daily life already makes evident: care shapes how space is negotiated, used, and sustained. Planning that centers care must shift its emphasis—from circulation to continuity, from technocratic cores to lived peripheries, and from static infrastructure to the embodied practices that quietly hold urban life together.

2.4 From Protection to Transformation: The Limits of Reactive Design

In recent years, spatial responses to gender-based violence in transport have often defaulted to protective segregation—such as women-only carriages or exclusion zones. While these may offer temporary relief, they reinforce binary assumptions and fail to confront the structural dynamics of exclusion (Soto et al., 2021; Valenti, 2015). They also ignore the full journey, particularly the first and last mile, where most harassment occurs.

These strategies often shift the burden of safety onto women, asking them to adjust their behavior instead of transforming the systems that create vulnerability in the first place. In contrast, gender-responsive planning calls for structural inclusion: participatory governance, gender-disaggregated data, intersectional analysis, and iterative design feedback (Beebeejaun, 2017; Whitzman et al., 2013).

The goal is not to design “safe” spaces for women in isolation but to build shared, negotiated spaces where people of all genders, ages, and identities can move, wait, and dwell without fear. In this view, protection is no longer the endpoint—it is the minimum condition for inclusive citizenship.

A paradigmatic example of this transition can be found in Santiago de Chile, where feminist planning collectives have advanced the concept of *ciudadanía urbana* plena—a model of full urban citizenship that asserts visibility, presence, and infrastructure for all users. Their initiatives integrate care into the urban fabric, proposing shaded walking corridors between homes and schools, rest areas designed for caregivers, public toilets with changing stations, and improved lighting in transitional areas (Stefoni, Fernández, & Faúndez, 2018).

Yet their greatest contribution lies beyond design: they demand a cultural shift in how cities are planned. Their processes begin not with abstract safety metrics, but with the lived experiences of those historically excluded. Their emphasis is not on “designing for women” as a static category, but on enabling the practices that sustain urban life—practices often rendered invisible by planning logics rooted in speed, productivity, and control.

2.5 Comparative Case Review of Gender-Sensitive Street Design

To situate Oaxaca’s experience within a broader field of practice, this study incorporates a **comparative synthesis** of international case studies where gender-sensitive design has played a central role in public realm interventions. These examples—ranging from the Global South to the Global North—were selected based on their emphasis on **safety, care, and spatial equity**.

1. **Bogotá, Colombia:** In Bogotá, initiatives such as *La Ruta de Equidad* and programs supported by the *Safe Cities* agenda combined spatial strategies (lighting, signaling, public art) with civic engagement processes (mapping walks, youth workshops) to create safer pathways near schools, markets, and transit hubs. These interventions emerged from sustained dialogue between civil society, city officials, and international partners, and emphasize the need to center care mobilities and non-linear commuting patterns (UN Women, 2021; New Economics Foundation, 2021).

2. **Rosario, Argentina:** Through participatory budgeting processes, the city of Rosario prioritized projects grounded in women's everyday spatial experiences. These included safer pedestrian corridors, shaded resting areas, and accessible public toilets—particularly in working-class neighborhoods. Developed in collaboration with local women's organizations, these interventions formed part of a broader feminist urban agenda that connects mobility justice with care infrastructure (Lerner & Schugurensky, 2005; World Bank, 2020).

3. **Quito, Ecuador:** As part of UN Women's *Safe Cities and Safe Public Spaces* initiative, the municipality of Quito implemented spatial and programmatic interventions such as gender-sensitive lighting, sidewalk widening, and targeted anti-harassment campaigns in transit corridors and public parks. These efforts were supported by mobile safety audits (e.g., via SafetiPin) and participatory co-design workshops, illustrating how community-led diagnostics can shape safer and more inclusive public space in cities marked by inequality and spatial fragmentation (UN Women, 2015; UN Women, 2021).

4. **New Delhi, India:** The *SafetiPin* audit system used mobile-based mapping to evaluate gendered safety near metro lines, identifying “on the street” as the most common site of harassment (Aono, 2019). Parameters such as visibility, foot traffic, and gender diversity were directly linked to perceived safety—highlighting the need for streets to support surveillance through presence, not isolation.

5. **Khayelitsha, Cape Town, South Africa:** A gender-sensitive upgrade plan responded to a high incidence of gender-based violence by proposing integrated infrastructure improvements such as durable surfaces, emergency phones, tree planting, and well-lit communal routes (UN-HABITAT, 2012). This case foregrounds how infrastructural deficits compound gendered vulnerabilities in informal or low-income settings.

6. **Vienna, Austria:** With over two decades of gender-sensitive planning experience, Vienna's interventions in park lighting, transit station design, and informal oversight mechanisms (e.g., kiosks, retail presence) were reviewed as models of spatial design that promotes passive safety and inclusive presence (UN-HABITAT, 2012; Aono, 2019).

7. **Umeå, Sweden:** The Lev Tunnel project exemplifies how structural gender inclusion can shape every aspect of a spatial intervention—from sightlines and accessibility to atmosphere and symbolism. The project's use of integrated workshops, combined with architectural attention to fear-based behaviors, positions it as a landmark in gender-sensitive street infrastructure (World Bank, 2020; Smart City Sweden, 2020).

This comparative review does not aim to construct a universal model. Instead, it illuminates the conditions under which gender-responsive frameworks emerge—through negotiation, contestation, and the materialization of social critique. Typologies, when read through this lens, are not static forms but spatial expressions of power, culture, and planning logics.

Ultimately, this methodology underscores the core argument of the paper: that gender is not an afterthought or additive in urban design—it is a structuring condition that shapes how cities are imagined, negotiated, and made.

3. Methodology: Framework-Building Through

3.1 Design-In-Formation and Best Practice

This research adopts a multi-scalar, interdisciplinary methodology to examine how gender-responsive street design can emerge during a project's formative design phase—even in the absence of an explicit feminist planning mandate. Rather than evaluating a completed intervention or applying a pre-defined framework, the study undertakes a post-hoc reconstruction of a gender-responsive lens based on civic feedback, feminist urban theory, and comparative precedent. The Oaxaca Historic Center Pedestrianization Project (OHCPP) serves as the core case study for this methodological approach.

Although the project remains in its design stage, it has produced five street typologies intended to guide interventions within the UNESCO-designated city core. Developed through iterative design processes and participatory workshops, these typologies offer a unique opportunity to analyze how gender considerations emerge, are negotiated, or remain absent in conceptual phases of street design. The analysis frames these moments not as successes or failures, but as indicators of a planning culture in transition.

3.2 Framework Development and Typological Analysis

Each typology was analyzed using a matrix to assess the presence, absence, or partial integration of these components. Designs were interpreted not as neutral outputs but as socio-spatial propositions that encode assumptions about who streets are for—and on what terms. Central to this methodology is the construction of a four-axis analytical framework that did not precede the project but emerged through reflection on its design outputs, participatory process, and global precedents of gender-sensitive street design in contexts such as Vienna, Barcelona, Bogotá, and Santiago. This comparative case review, which is now integrated into the theoretical foundation, informed the structure and components of the framework.

The resulting framework includes:

- **Gender-Inclusive Design Principles** – foundational values such as safety, visibility, accessibility, and care. These respond to gendered mechanisms: for instance, lighting and clear sightlines address harassment risk; continuous, step-free routes support trip-chaining with strollers and trolleys; active edges and “eyes on the street” increase passive surveillance; and shade/rest enable time-poor caregivers and elders to pause safely. These are derived from feminist geography and planning literature, which underscore the spatial manifestations of gender inequality in everyday urban life (Beebeejaun, 2017; Kern, 2020; Sánchez de Madariaga, 2013).

- **Gender-Sensitive Interventions** – physical design strategies that respond to those principles, including traffic calming, seating, legible lighting, and wayfinding. While seemingly ‘universal’, their gender relevance is operational: speed reduction lowers exposure

during crossings for those accompanying children; legible lighting and landmarks reduce fear-based avoidance; seating and curb radii sized for strollers and mobility aids facilitate caregiving mobilities (Koskela, 1999; Ceccato & Loukaitou-Sideris, 2022).

- **Gender-Responsive Planning Processes** – participatory tools and feedback loops that **center care-based knowledge and diverse mobilities**, particularly those of women, children, and elders. We define these procedurally (co-definition of problems, co-prioritization of segments, staged evaluation) and institutionally (clear representatives for monitoring and publicly reported indicators).

- **Typological Applications** – the extent to which these values are **embedded —consistently or unevenly— across the five proposed street typologies**.

Where feasible, we also recorded the anticipated universal co-benefits (e.g., lighting that aids low-vision users, shade that reduces heat stress for older adults), to clarify how gender-sensitive design advances broader accessibility goals.

3.3 Participatory Process Documentation and Thematic Input Analysis

The OHCPP integrated multiple rounds of civic engagement involving civil society actors, cultural institutions, women’s organizations, and neighborhood residents. Participants were recruited through a combination of community outreach led by cultural institutions and direct invitations to neighborhood associations and women’s groups. This approach ensured participation from stakeholders whose daily mobility patterns were most directly affected by the proposed interventions. A notable outcome was that women comprised 58% of participants across the workshops. This was not pre-engineered but reflected the strong involvement of women in Oaxaca’s caregiving and mobility networks, where safety and accessibility concerns are already central to daily life.

These forums generated insight into: a) locally perceived unsafe zones; b) infrastructure gaps tied to caregiving and elder mobility; c) the desire for welcoming, inclusive, and non-securitized public spaces. Rather than relying on formal surveys, this study draws on thematic analysis of qualitative materials: visual mapping exercises, feedback forms, and workshop transcripts. These inputs were cross-referenced against the gender-responsive framework to evaluate how civic concerns—particularly from women and caregivers—were amplified, negotiated, or sidelined in the typological proposals.

Importantly, participation is not idealized here. Drawing from feminist planning literature, the analysis treats participation as a contested site of influence—focusing not only on what was said, but on what was made visible, actionable, or institutionally absorbed. At the same time, we acknowledge limits of representativeness: informal and peripheral neighborhoods were underrepresented in the workshops, which shaped both the scope of the civic insights and the typological analysis.

4. Case Study: Building A Gender-Responsive Framework in Oaxaca

4.1 Oaxaca as Transition: From Walkability to Spatial Justice

In Oaxaca’s historic center, the Oaxaca Historic Center Pedestrianization Project (OHCPP)—funded by the Inter-American Development Bank (IDB)—was not designed with a primary focus on gender, although it included a gender dimension in its broader objectives. Yet it unintentionally created space for questions of care, visibility, and safety to emerge. As women’s groups and caregivers began articulating their concerns—particularly around lighting, rest infrastructure, and spatial legibility—the project began to shift in orientation and scope. The discourse moved from circulation to care, from flow to dignity. This shift was neither linear nor complete, but it marked a turning point: a recognition that the street is not merely physical infrastructure, but a social contract. **This transition reflects not only a design evolution but also a deeper epistemic shift—one that redefines what counts as knowledge in urban practice. As explored in the theoretical sections, streets are never neutral: they materialize social relations, hierarchies, and everyday negotiations of power.**

What the OHCPP illustrates is not a finalized solution, but a moment of transition in planning culture. It demonstrates how streets can become platforms for contestation, adaptation, and epistemic pluralism—spaces where different ways of knowing the city are not only expressed but legitimized. In contrast to technocratic logics that reduce public space to metrics of efficiency or flow, epistemic pluralism insists that knowledge is multiple, embodied, and relational. When gender-responsive approaches are integrated into design logic rather than appended as afterthoughts, streets cease to be neutral containers and become sites of redistribution—of space, attention, and power. **In this sense, the OHCPP stands not as an isolated design exercise but as part of a wider rethinking of urban epistemologies in Latin America—where feminist and decolonial perspectives challenge the technocratic ideal of neutrality in planning.**

This reframing is especially urgent in contexts like Oaxaca, where colonial spatial hierarchies and fragmented governance structures have long marginalized non-institutional voices. The dynamics discussed in earlier sections gain sharper definition when read through this lens. In Oaxaca, care is not a metaphor but a spatial logic practiced daily under precarious conditions. The burdens of navigating the city—time, risk, and emotional labor—are unequally distributed. The absence of formal infrastructure is often compensated by collective, feminized routines that remain largely unacknowledged. When the OHCPP engaged with women and caregivers, it inadvertently made these realities visible, challenging the assumption that walkability is a neutral or universally beneficial objective.

Likewise, the shift from protection to transformation is not merely conceptual—it is a material and political challenge within Oaxaca’s historic center. Safety concerns are real, but so too is the risk of addressing them through spatial exclusion or symbolic gestures. The demand for transformation—voiced implicitly through workshops and design critiques—was

not for separation, but for shared use grounded in care, continuity, and everyday presence. These demands signal a public already engaged in planning, testing and redefining the boundaries of urban design.

The street, therefore, is not simply an object of design but a process of negotiation—a living interface where care, power, and coexistence are continually redefined. Taken together, these subchapters converge on a single insight: gender-responsive street design cannot be retrofitted. It must be embedded from the outset—especially in cities where urban interventions are layered over complex socio-historical terrain. In Oaxaca, this means reading the street not only as a surface to be improved, but as a layered site of power, knowledge, and relational negotiation.

This paper builds upon that insight to propose a framework for street design that is not only inclusive but structurally reoriented toward equity. In doing so, it joins a growing body of work that calls for planning practices capable of recognizing difference—not as a deviation from normativity, but as the constitutive condition of public space.

4.2. Structuring a Gender-Responsive Framework

Drawing from feminist urbanism literature, international best practices, and insights from participatory workshops, a comprehensive gender-responsive framework emerged, structured around three interrelated pillars: Gender-Inclusive Design Principles, Gender-Sensitive Design Interventions, and Gender-Responsive Planning Processes, bound together by a mechanism of Continuous Feedback Loops.

Pillar 1: Gender-Inclusive Design Principles

These foundational principles provide overarching guidelines that orient all spatial and procedural decisions, emphasizing safety, accessibility, and social interaction:

- 1. Safety for All: Streets must actively minimize gender-based violence and harassment risks by ensuring visibility, ample and strategically placed lighting, and spaces that foster public oversight.
- 2. Accessibility for Diverse Users: Infrastructure must cater to users with varying mobility capacities, caregiving responsibilities, or disabilities, ensuring universal standards such as ramps, adequate sidewalk widths, clear pathways, and seating.
- 3. Public Spaces for Social Interaction: Design should create welcoming environments through rest areas, benches, and shade, fostering spaces for inclusive gathering and social activity that acknowledge women’s presence and participation as fundamental.

Pillar 2: Gender-Sensitive Design Interventions

These interventions translate principles into concrete, actionable elements integrated within the physical streetscape, specifically addressing gendered experiences of space and mobility:

- 1. Traffic-Calming Measures: Reducing vehicle speed and creating safer environments for pedestrians, benefiting women and children who typically have more complex travel patterns and heightened safety concerns.
- 2. Pedestrian Priority Zones: Establishing dedicated pedestrian corridors that significantly limit vehicular intrusion, prioritizing safe, continuous, and comfortable pedestrian mobility.
- 3. Safe, Comfortable Rest Areas: Providing strategically located and well-lit areas with seating and amenities, addressing caregiving mobilities, and offering secure spaces for pause and interaction.
- 4. Wayfinding Systems: Implementing clear, intuitive, and inclusive signage that supports ease of navigation, improving perceived safety, especially for vulnerable groups unfamiliar with the area or experiencing mobility constraints.

Pillar 3: Gender-Responsive Planning Processes

This pillar ensures that gender inclusion is structurally embedded within governance and planning culture rather than treated as ancillary:

- 1. Inclusive Stakeholder Engagement: Consistently prioritizing participation from women, caregivers, and marginalized populations in planning and decision-making forums to ensure lived experiences inform design outcomes.
- 2. Disaggregated Data Collection: Routinely gathering gender-sensitive mobility data, documenting usage patterns, safety incidents, and perceived risks to inform responsive design adaptations.
- 3. Intersectionality in Planning: Recognizing overlapping identities and vulnerabilities (e.g., age, socioeconomic status, ethnicity, caregiving roles) to create nuanced, targeted interventions rather than generalized solutions.

Continuous Feedback Loops

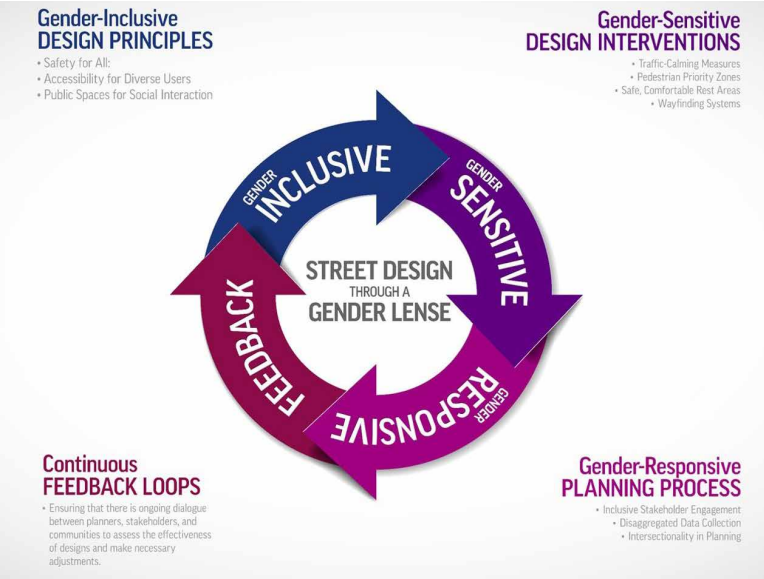


Figure 1. Gender-Responsive Street Design Framework (own elaboration, 2025).

Recognizing that gender-responsive design is iterative rather than static, the framework emphasizes ongoing mechanisms for feedback and adjustment. Regular community consultations, post-intervention surveys, and adaptive management practices ensure that streets remain responsive to evolving gendered needs and challenges. This cyclical process fosters accountability, continuous improvement, and adaptability within urban governance.

4.3 The Typologies as Spatial Hypotheses

A defining feature of the OHCPP is its proposal of five street typologies, each crafted to respond to specific urban conditions within the historic center. These typologies do not represent finalized designs but act as spatial hypotheses—testbeds through which the city’s emerging design culture is made visible. When analyzed through the gender-responsive framework, they reveal both incremental shifts and persistent gaps.

A. **Typology A: Pedestrian Priority Streets:** These designs prioritize wide, continuous sidewalks, reduced vehicle access, and public amenities such as benches, trees, and shade. Of all the typologies, this one aligns most closely with gender-inclusive principles, responding directly to concerns raised by caregivers and elderly users. Strong lighting and visibility measures offer spatial responses to gendered fear, while the reduced vehicular dominance fosters a sense of comfort and autonomy for those on foot.

B. **Typology B: Mixed-Use, Low-Speed Zones:** Intended to balance economic vitality with accessibility, this typology proposes shared spaces where pedestrians and vehicles coexist. However, its effectiveness depends on the strength of its calming interventions and spatial delineation. Without physical separation or protective buffers, these zones may reproduce ambiguity and reinforce hierarchies, benefiting confident male cyclists or drivers over more vulnerable users such as women or the elderly.

C. **Typology C: Green Mobility Corridors:** These streets integrate landscaping and cycling infrastructure. While aligned with sustainability goals, their gender impact is mixed. In Oaxaca, cycling remains a male-dominated mode due to cultural perceptions and infrastructural risk. For these corridors to become inclusive, they must incorporate design adaptations that support trip chaining and caregiving (e.g., wider lanes, stopping zones, links to schools and markets), as well as protected bike paths that address safety anxieties specific to women.

D. **Typology D: Transitional Streets:** Positioned at the boundary between pedestrianized zones and vehicular corridors, this typology reflects the project’s incremental logic. These are liminal spaces—part pedestrian, part car-centric—that tend to suffer from spatial ambiguity. Without clear prioritization, these streets can fall short in every category of the gender-responsive framework: interventions are partial, design signals are inconsistent, and users are left to negotiate space hierarchies without clarity or protection.

E. **Typology E (Implied/Peripheral):** Perhaps most telling is the absence of formal typologies for Oaxaca’s informal or peripheral neighborhoods. This absence is not just a design

gap but a political one. If typologies are not eventually extended into underserved zones—where women’s mobility burdens are greatest—the OHCPP risks reinforcing center-periphery inequalities under the guise of innovation. A feminist planning perspective highlights this as one of the most urgent areas for structural correction.

V. Findings: Towards a Transition in Gender-Responsive

5. Street Design

5.1 Key Findings: Planning in Transition, Gender in Formation

The OHCPP offers a nuanced and generative case of urban design in transition—a moment when planning culture begins to shift, but where the tools, mandates, and institutional language for true gender responsiveness remain emergent. When evaluated through the proposed framework—comprised of inclusive design principles, sensitive interventions, responsive planning processes, and feedback loops—several key insights emerge:

1. **Participation is necessary, but not sufficient:** The presence of women and caregivers in the participatory workshops (58% of participants) undoubtedly shaped the project’s spatial priorities. Concerns over safety, lighting, seating, and walkability were heard and visibly reflected in the design proposals. However, without mechanisms for tracking how these insights translate into implementation—and without formal structures to ensure ongoing gender-disaggregated evaluation—the impact of participation risks being symbolic rather than structural. Gender-responsive planning requires not just consultation, but governance embedded with accountability.

It also requires feedback loops that are not only technical, but political: spaces where those who participate can also evaluate outcomes, push back against exclusions, and shape revisions. Without this, participation becomes an extractive exercise rather than a redistributive one.

2. **Design typologies contain both innovation and inertia:** The five OHCPP typologies reflect meaningful shifts toward inclusion—particularly in Typology A (Pedestrian Priority Streets), which aligns most closely with feminist spatial principles. However, others remain limited by ambiguous logics (e.g., low-speed shared zones) or embedded exclusions (e.g., cycling-focused corridors in a male-dominated cycling culture).

Most importantly, the absence of typologies for informal or peripheral streets should be framed as an internal limitation of the project itself. While OHCPP focuses on the historic core, its typological approach implies broader applicability. By omitting underserved areas, the project risks reinforcing centre-periphery inequalities and overlooking the mobility burdens most acutely felt in caregiving-intensive neighborhoods. This absence is not trivial: it reveals a structural selectivity within planning practice, reproducing the very hierarchies that gender-sensitive design seeks to dismantle.

3. **Incrementalism opens space for experimentation—but also for exclusion:**

The OHCPP's phased approach follows a tactical urbanism logic, allowing for short-term interventions that can evolve through feedback. In theory, this is a strength. But from a gender equity perspective, it creates a temporal hierarchy of who benefits first—and who waits. If implementation stalls before reaching lower-income or historically underserved neighborhoods, the project could exacerbate spatial inequalities under the guise of equity. Gender-responsive transitions must be equitable not only in form but in timing. Incrementalism, without safeguards, can reinforce path dependency—locking cities into design choices that are technically efficient but socially regressive. Sequencing matters: when pilot interventions are only tested in well-resourced zones, broader application to marginalized contexts becomes harder to justify, fund, or replicate.

4. **Gender is not a design feature—it is a structural condition:** One of the most critical findings is that gender cannot be “added” to a street typology. It must be embedded from the outset—as a planning value, a design logic, and a governance requirement. Many of the OHCPP's most promising elements—active frontages, benches, shade, lighting—are effective not because they are labeled “feminist,” but because they respond to lived realities of exclusion. Moreover, the design principles that emerge from feminist urbanism often extend far beyond the needs of women alone. Features such as improved lighting, shaded and accessible rest areas, and continuous pedestrian pathways respond directly to gendered exclusions, but they also support a wide spectrum of vulnerable users—older adults, children, and people with reduced mobility. In this sense, gender-sensitive design can be understood as a pathway toward universal design, where interventions grounded in equity and care simultaneously enhance safety, comfort, and accessibility for all urban residents. The goal is not to design streets for women, but to create streets where gendered vulnerability is anticipated and mitigated through spatial, social, and institutional practices.

5. **Frameworks matter—especially when institutional memory is fragile:** The creation of a post-hoc gender-responsive framework in this project underscores the value of structured tools for analysis and design. In contexts where policies shift with administrations and projects unfold across electoral cycles, frameworks can serve as anchors for continuity. By making gender considerations explicit, interrelated, and assessable, the framework developed here can help transition design culture from intuitive inclusion to intentional accountability. In the absence of policy continuity, they can preserve collective learning, guide implementation across actors, and enable future planners to identify what was done, what was missing, and where to go next.

5.2 Conclusion: Designing Transitions, Not Just Streets

This Gender-Responsive Street Design Framework does not offer a definitive blueprint for gender-equitable street design. Instead, it offers something perhaps more valuable: a window into a planning culture in motion—struggling, negotiating, and learning how to embed feminist spatial principles within an institutionally fragmented and historically layered

red urban context.

From the perspective of the Future Design of Streets and its focus on transition, Oaxaca demonstrates that change rarely begins with ideal plans. It begins with friction—through contested processes where community demands, design experimentation, and institutional receptivity collide. It is in these moments of tension that gendered concerns surface—not as add-ons to pre-existing typologies, but as drivers that begin to reorient planning logics from mobility efficiency toward spatial justice. Yet the question lingers: how far can these shifts go without deeper structural transformation? If pedestrianization is to move beyond technocratic intervention—if it is to confront and undo inherited hierarchies of gender, class, and spatial privilege—it must be anchored in long-term governance, backed by policy mandates, sustained funding, and mechanisms for community oversight. Otherwise, there is a risk that well-intentioned designs will merely beautify exclusion, masking inequality without redistributing power.

The framework presented here—grounded in principles, interventions, planning processes, and continuous feedback loops—offers one way to make these transitions more visible and assessable. It is not a universal solution, but a lens through which to identify where inclusion starts, where it falters, and what is required to move it forward. In Oaxaca, this lens has illuminated both meaningful gains and persistent gaps, offering lessons that extend beyond the city itself. Ultimately, the future of street design depends not only on what is built, but on how planning cultures learn to listen, adapt, and redistribute—not just space, but power. Feminist urbanism is not a design aesthetic, but a political demand: that cities recognize care, difference, and collective agency as fundamental to urban life. If cities are to be just, their streets must become infrastructures of dignity—places where all people, in their full diversity, can move, pause, and belong.

While the framework proposed in this paper emerged from the specific context of Oaxaca, its structure—centered on design principles, interventions, participatory processes, and feedback mechanisms—holds broader relevance. Applied critically and adapted to local conditions, it offers a transferable tool for other cities grappling with similar asymmetries. Its true value lies not in prescribing solutions, but in helping cities ask better questions—about who is present, who is absent, and what it will take to build streets that truly belong to all.

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Plenary and Parallel sessions

DAY II

27 JUNE 2025

9.15 - 18.30

Plenary sessions

DAY III

28 JUNE 2025

10.00 - 12.00

Guided visit, historical centre of
Guimarães, by Ricardo Rodrigues

PROGRAMME

Streets are rich and layered societal spaces. They are an integral part of our daily living environment: as social spaces that function as public, collective, and democratic spaces; as natural spaces, providing habitats for flora and fauna, including trees, soil, and water; and as mobility spaces, serving as essential components of broader mobility networks, offering large-scale connections and local accessibility.

In recent decades, the way streets are used and transformed has fundamentally changed. In many cities, towns, and villages across Europe, we can find beautiful, inspiring, meaningful, and collectively created examples of recent street projects. These go beyond the scale of a single project, involving a transformation of the entire street network and living environment.

A rich spectrum of possible solutions – making streets collective spaces – is available to everyone, often based on social and natural values, where mobility is rebalanced to reduce its dominance in street spaces.

As society rapidly evolves and major social challenges emerge, we must question how we use and design our streets. This raises the critical question: 'If we know all the solutions, why can't we accelerate the action?'

Our second international conference, the Future Design of Streets, gathered actors/players from diverse fields and contexts for reflection, debates, and shared knowledge and experiences on designing and planning better streets for current and future generations. In three days, it connected academia with practitioners, bridged theory and best practices.

The conference was organised by 'the Future Design of Streets association' in collaboration with the 'EAAD School of Architecture, Art, and Design' and the research unit 'Landscape, Heritage and Territory Laboratory (Lab2PT),' both from the University of Minho, and took place at the Centro Cultural Vila Flor in Guimarães, Portugal.

DAY I

26 JUNE 2025

8.45 – 9.15	Registration
9.15-11.00	Plenary Session - Opening Session Ivo Oliveira Paulo Silva, CM Guimarães Paulo Cruz, Presidente EAAD Opening presentation Éric Alonzo
11.00-11.30	Coffee break + Poster Sessions #1
11.30-13.00	Parallel Session #1
13.00-14.30	Lunch
14.30-16.00	Parallel Session #2
16.00-16.30	Coffee break + Poster Sessions #2
16.30-18.00	Plenary Session - Roads to Streets METREX Olga Pereira, Maria João Matos, José Manuel Ferreira, Paul Lecroart, Henk Bouwman, Daniel Casas-Valle
18.00	Book presentation David Sim, Soft City (parallel programme)

POSTER SESSIONS #1 11.00-11.30

Ana Tsou
Inês Osório de Castro
Eva Rusch
François Decoster
Jiayu (Joslyn) Sun

POSTER SESSIONS #2 16.00-16.30

Nazanin Moghaddam
Robert Tensen
Sandra Brito
Tadej Gregoric

DAY II

27 JUNE 2025

8.45 – 9.15	Registration
9.15-11.00	Opening Session Daniel Casas-Valle Plenary Session - SOCIAL Agustina Martire Margarida Marques David Sim Sara Sucena (moderator)
11.00-11.30	Coffee break
11.30-13.00	Plenary session – NATURE Marta Garcia Chico Juan Luis Rivas Rosário Salema Ivo Oliveira (moderator)
13.00-14.30	Lunch
14.30-16.00	Plenary session – MOBILITY Michael Glotz-Richter Giacomo Gallo João Rafael Santos Nuno Lavrador Mário Alves (moderator)
16.00-16.30	Coffee break
16.30-18.00	Plenary session – TRANSITION Maria Vassilakou Demetrio Scopelliti Daniel Casas-Valle (moderator)
18.00	Closing session - WHAT'S NEXT Daniel Casas-Valle / Ivo Oliveira
19.30	Dinner (optional)

KEYNOTE SPEAKERS / MODERATION

Agustina Martire
Daniel Casas-Valle
David Sim
Demetrio Scopelliti
Éric Alonzo
Giacomo Gallo
Henk Bouwman
Ivo Oliveira
João Rafael Santos
José Manuel Ferreira
Juan Luis Rivas
Margarida Marques
Maria João Matos
Maria Vassilakou
Mário Alves
Marta Garcia Chico
Michael Glotz-Richter
Nuno Lavrador
Olga Pereira
Paul Lecroart
Paulo Cruz
Paulo Silva
Rosário Salema
Sara Sucena

PARALLEL SESSIONS

Adam Tranter
Ana Bonifácio
Beatriz Vilarinho
Catarina Breia Dias
Catarina Cadima
Chris Visser
Daniela Salazar
David Ortega-Martinez
Diana Gouveia
Eva Rusch
Filipa Corais
Francisca Magalhães
Gargi Roy
Hara Liakou
Inês Galvão
Inês Sarti Pascoal
John Dales
Juan Luis Rivas Navarro
Juliana Carvalho,
Kim Carlotta von Schönfeld
Leonel Alegre
Luis Barraza Cardenas
Manuel Caldeira
Marcela Percu
Margarida Lopes
Maria Ângela Cunha
Nazanin Moghaddam
Olaf Gabriel Dilling
Paulo Farinha-Marques
Pieter de Haan
Reena Mahajan
Rita Araújo
Rute Nieto Ferreira
Simon De Boeck
Telmo Escapil-Inchauspé
Viktoria Shafarenko
Wouter Florizoone

POSTER SESSIONS

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Tadej Gregoric

CONFERENCE

the Future Design of Streets 2nd International Conference
Centro Cultural Vila Flor, Guimarães, 26-27 June 2025

Chairs

Daniel Casas-Valle
Ivo Oliveira

Organisation Team

Carina Gomes
Catarina Breia Dias
Daniel Casas-Valle
Ivo Oliveira

Scientific Committee

Alexandra Paio
André Fontes
Bruno Moreira
Cristina Cavaco
Frederico Moura e Sá
João Ferreira
João Leite
José Carlos Mota
Nuno Travasso
Sara Sucena
Sérgio Proença
Rodrigo Coelho

Further information

www.thefuturedesignofstreets.eu/conference-2025

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University of Minho: Laboratory of Landscapes, Heritage and Territory
the Future Design of Streets association



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Conference Proceedings

Daniel Casas-Valle

Ivo Oliveira

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