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## Living and Walking in Cities Mobility, Public Space and Spatial Justice

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# TeMA

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Land Use, Mobility and Environment

*Special Issue 1.2026*

## Living and walking in cities: Mobility, Public Space and Spatial Justice

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**Editorial correspondence**

Laboratory of Land Use Mobility and Environment  
DICEA - Department of Civil, Building and Environmental Engineering  
University of Naples "Federico II"  
Piazzale Tecchio, 80  
80125 Naples

web: [www.serena.unina.it/index.php/tema](http://www.serena.unina.it/index.php/tema)  
e-mail: [redazione.tema@unina.it](mailto:redazione.tema@unina.it)

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*Special Issue 1.2026*

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## Intermediate railway stations in medium-to-low density areas. An analysis of five European metropolitan contexts

Ludovica Dangelo <sup>a\*</sup>, Marika Fior <sup>b</sup>, Paolo Galuzzi <sup>c</sup>

<sup>a</sup> Department of Planning, Design and Technology of Architecture  
Sapienza University, Rome, Italy  
e-mail: ludovica.dangelo@uniroma1.it  
ORCID: <https://orcid.org/009-0004-2779-8398>  
\* Corresponding author

<sup>b</sup> Department of Planning, Design and Technology of Architecture  
Sapienza University, Rome, Italy  
e-mail: marika.fior@uniroma1.it  
ORCID: <https://orcid.org/0000-0003-4290-9573>

<sup>c</sup> Department of Planning, Design and Technology of Architecture  
Sapienza University, Rome, Italy  
e-mail: paolo.galuzzi@uniroma1.it  
ORCID: <https://orcid.org/0000-0001-8631-6863>

### Abstract

Networks are essential to ensuring the balance of metropolitan structures, especially in medium-to-low density areas, where their vitality depends on the integration of functions, services, and accessibility. In contrast to the scientific interest in "large stations", the contribution focuses on "intermediate stations", with the aim of demonstrating not only their strategic role in urban regeneration processes based on the implementation of intermodality and multimodality, but also the wide diversity that characterises them both in terms of the state of the existing context and the project opportunities they offer. The paper proposes a comparative analysis of five European Metropolitan Cities (Milan, Berlin, Paris, Barcelona, London), selecting stations belonging to the metropolitan railway systems, with average passenger volumes (1,500-10,000/day), on historic lines (dating back to the mid-19th century) and in municipalities with densities between 1-3,000 inhabitants/km<sup>2</sup>. The analysis shows that stations with the same service characteristics that define them as "intermediate" can produce radically different regenerative results in terms of context because the existing pedestrian accessibility, functional composition of urban areas, and degree of transport intermodality are different. This highlights the importance of considering the characteristics and dynamics of contexts when classifying and planning railway node reorganisations on a national scale.

### Keywords

Railway system; Integrated mobility; Metropolitan cities

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## 1. The role of mobility networks in the metropolised city

### 1.2 An overview of Italian metropolitan areas

Metropolisation is described as the integration of different aggregates and forms of diffusion relating to residential, economic and social practices, as well as daily life (Ricci, 2005), shaping cities defined by extensive functional relations, diversity of daily mobility and lifestyles spread over a wide and fragmented territory, whose ordering principles depart from hierarchical or positional principles, configuring a new city (Galuzzi et al., 2018). This phenomenon has not only involved large cities, but also small and medium-sized ones (Oliva, 2010), causing a condition of unsustainability in the contemporary city, determined by the excessive consumption of land, the discontinuity of ecological networks, the progressive loss of public space -and therefore of the possibility of fully exercising the "right to the city" (Borja, 2005; Lefebvre, 2009)- and a mobility based on multi-directional travel, mainly by road. In fact, complex mobility flows have emerged -both routine and occasional- driven by the resident population as well as productive dynamics. The resulting spatial forms are closely linked to the development of private mobility, which has enabled connectivity but at the same time fostered growing dependence on car use (Colleoni, 2022). However, in Italy, the functional separation between urban activities, driven by post-war planning (Gargiulo, 2007), influenced the increase in travel demand. Yet, this rise in mobility needs has not been matched by a corresponding development of the public transport infrastructure, as a result, the country now finds itself "lagging behind" with the development and efficiency of several networks and with a greater difficulty of intervention, despite other European countries which, as early as the 1980s, recognised the strategic role of the railway in sustainable urban planning. As yet outlined by Dell'Orto et al. (1997), these countries prioritised investing in the efficiency and capacity of rail-based mass transit systems as the main driver of spatial localisation in terms of settlement growth and urban transformation.

In this context, the analysis includes a comparison with different European metropolitan cities which have undertaken more proactive and structured approaches to a rail-oriented development. Specifically, we selected cities such as Berlin, Barcelona, London, and Paris, as they exemplify large metropolitan areas with extensive metropolitan railway systems. Networks such as the German S-Bahn, the Spanish Rodalies, the London Overground, and the French RER have evolved significantly over time, becoming dense, integrated systems capable of supporting both urban and peri-urban mobility in a sustainable and efficient manner.

Fully aware that a comprehensive overview of the entire European context is not feasible within the scope of this research, we assumed that many of the dynamics and solutions adopted in these cities may reflect those found in other European realities. Italy was included as the primary national case study, not only due to our direct familiarity with its socio-spatial and infrastructural context, but also to allow for a more in-depth analysis of its specific challenges and criticalities. This comparative framework highlights the differences in strategies and outcomes between the Italian case and other European metropolitan models. While acknowledging the diversity of the European context, we avoided presenting a generic scenario and instead focused on the Italian infrastructural development. Furthermore, the selection of these cities was guided by the availability and accessibility of reliable and up-to-date data, which was essential for conducting a meaningful comparative analysis. Furthermore, the selection of these cities was guided by the availability and accessibility of reliable and up-to-date data, which was essential for conducting a meaningful comparative analysis.

In the Italian scenario, the absence of a properly integrated public transport system, beginning with the railway networks which play a key role in maintaining metropolitan balance (Campos Venuti, 2005), has hindered the development of widespread, interconnected mobility networks, reducing the effectiveness of serving even the most peripheral areas (Moscarelli et al., 2017). The dispersion of settlements and activities has led to a significant increase in mobility, with a large proportion consisting of commuting, as the place of residence and the place of work are increasingly no longer the same. As Martinotti (Martinotti, 1993) observed large cities

and their hinterlands continue to grow because economic factors still make cities the most attractive location for businesses and individuals. In addition, the relationship between the fragmented morphology of agglomerations and the increase in mass motorisation emerges clearly from demographic data<sup>1</sup>, which shows population growth in the medium to short term in the municipalities of the first and second ring of the main Metropolitan Cities, combined with increasing land occupation (Colleoni, 2022).

This spatial dispersion has been sustained by road mobility and the increasingly widespread use of the private car, which have ensured increasing connectivity between residential, work and service areas that are often far apart. In this context, the two-way flows relating to home-work movements have been joined over time by the increasingly frequent zigzagging flows of occasional movements, which concern large cities and their functional complexity, and which add to commuting the movements of work, leisure and daily activities (Martinotti, 1993). Moreover, as stated in a European Commission document (European Commission, 2019) the flows of people and goods are set to increase further in the coming decades.

### 1.3 The relationship between mobility and urban planning

The increase in travel has led to significant congestion and pollution problems in Italian cities, which continue to rely primarily on car transport. It was in the 1980s (Banister, 2008) that the concept of sustainable mobility began to take shape, later finding its first formal definition in the Green Paper on the Impact of Transport on the Environment, published by the European Commission in 1992 (European Commission, 1992). This document highlighted how, despite the transport sector's contribution to global economic growth, international trade and tourism, it had also caused severe environmental damage -including pollution from fossil fuels, road accidents, and a significant dependence on energy (Holden et al., 2020).

The debate around mobility networks thus became entangled with environmental concerns, but it also developed through a range of disciplinary perspectives -from urban planning to geography, from social sciences to transport planning (Pucci, 2015)- all pointing to the need for an integrated approach to mobility, one that ensures not only environmental sustainability but also the social and functional sustainability of transport systems. Within this context, increasing attention has been paid to the integration of transport and urban planning, giving rise to development strategies oriented towards public transport and placing accessibility at the core of spatial planning, thereby rethinking land use and urban distances (Kunst, 2016). As several authors have highlighted, the link between public transport accessibility and social inclusion plays a crucial role in achieving greater accessibility to relevant urban functions, while also aiming to minimise car dependency and rationalise travel (Fusi & Tiboni, 2024; Sezer et al., 2024). Over the years, various approaches have emerged, one of the most influential being Transit-Oriented Development (TOD), which originated in the early 1990s in the United States (Calthorpe, 1993). This approach promotes the integrated planning of transport and land use, with the goal of encouraging the use of mass transit systems -particularly rail- through the urban development of areas surrounding stations. The model is based on three core principles, the so-called "3 Ds": density, diversity, and design (Cervero & Kockelman, 1997). Building on these studies, subsequent research has progressively refined the analytical framework of TOD (Ewing & Cervero, 2010), introducing indicators that move beyond traditional measures to incorporate additional variables -evolving from the "5 Ds" to more comprehensive "7 Ds" approaches- in order to better capture the different urban contexts and travel behaviours (Robillard et al., 2025). However, approaches like TOD are not always easily applicable, especially in the context of metropolised city, which is characterised by varied settlement patterns and where the social and spatial diversity of urban forms presents significant challenges to traditional land use and transport planning (Nenseth & Røe, 2024). This has led to a critical debate about the most effective ways to intervene in dispersed, low-density areas, where models of transport-land use integration or proximity

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<sup>1</sup> Istat (2021) Permanent Census of Population and Housing in Italy. Results for the Years 2018–2019.

strategies, such as the 15-minute city, may be ineffective, difficult to replicate or unsuitable for local needs. Several authors (Cervero & Day, 2008; Brès, 2014; Staricco & Vitale Brovarone, 2020) have highlighted the need to adapt these models to the specificities of contexts, promoting more flexible approaches oriented towards polycentric forms of development, and the reorganisation of mobility systems in diffuse territories, seeking interconnection not only with urban cores but with entire urban and rural regions (Bertolini, 2023).

#### 1.4 From high-speed to minor railways: the centre of the debate

In recent decades, international literature has given considerable attention to high-speed rail (HSR) stations, often in relation to their territorial and urban planning implications. Several studies from the Spanish context have examined the critical issues arising from the peripheral location of many HSR stations, which were newly built along dedicated high-speed lines, often far from urban centres. A number of contributions (Bellet, 2016; Ribalaygua & Perez-Del-Caño, 2019) have explored in depth the planning strategies and critical issues related to the territorial integration and accessibility of these stations, focusing on low-density contexts and their isolated position with respect to the urban fabric, from which emerges a reflection on the social and territorial impacts. Along these lines, Miralles and Garcia (Miralles & Garcia, 2017) offer both a theoretical and operational framework for the optimal location of HSR stations, highlighting how infrastructure decisions influence urban mobility and territorial dynamics, though not necessarily producing positive effects on urban development by default. In the Italian context as well, HSR stations -particularly their accessibility and spatial positioning- have drawn significant attention, especially in major cities (Staricco & Vitale Brovarone, 2020). The work of some authors (Panuccio, 2024), for instance, examines, HSR stations -in particular the AV Mediopadana station in Emilia-Romagna and the AV Napoli-Afragola station in Campania- which, while representing powerful symbolic and territorial infrastructures, do not automatically trigger virtuous urban regeneration processes unless they are integrated into a broader strategic and intermodal planning vision. Complementary analyses by other authors (Beria et al., 2018) show how HSR programmes in both Italy and Spain, despite growing demand, have been oversized, compromising their economic sustainability and territorial effectiveness.

Another perspective is that numerous studies have focused on secondary and minor railway lines connecting fragile inland areas. These lines are at risk of abandonment due to low demand, and many have already closed for technical or economic reasons. Various scholars (Corradi & Massacesi, 2016; Cerasoli & Mattarocci, 2019; Spagnoli, 2022), alongside national programmes and strategies (SNAI, 2021; RFI, 2022; FFS, 2022), have shown interest in this field, which addresses the marginalisation of fragile territories. Several authors have proposed ways to reuse these infrastructures (Ravagnan & Amato, 2020), while others have highlighted their potential as tourist routes (Peira et al., 2022), greenways (ISFORT, 2004; Tadini & Piva, 2025), and drivers of local sustainable development (Spagnoli & Varasano, 2022). Furthermore, they are increasingly recognised as part of the national heritage, linked to the wider railway patrimony distributed throughout the country (Oppido et al., 2017; Borges, 2023). In this context, studies have been conducted at railway stations to identify best practices for their reuse and explore the roles they could fulfil when they are no longer used for their original purpose. These studies have considered ways in which stations could serve local communities or become part of cycling and tourism itineraries (RFI, 2016; Radogna, 2022).

Despite the focus on high-speed rail services and existing research on smaller railways and stations, there are still only a limited number of studies focusing on smaller regional and metropolitan transport nodes, especially in large cities, even though they play a strategic role in everyday mobility. As Van Acker and Triggianese (Van Acker & Triggianese, 2021) emphasise, medium-sized railway stations require a different approach from the ambitious redevelopment plans typical of HSR hubs. A context-oriented approach with a different spatial vision, capable of placing the station within strategies oriented to the local scale and consistent with the territories in which it is located.

## 1.5 Rail-based strategy of “intermediate stations” in urban regeneration

In this regard, the research begins with the concept of “cura del ferro” (rail-based care) for cities, emphasising the importance of integrating mobility planning into urban planning tools and recognising the strategic role of the rail network as a feasible alternative to private transport. The expression “rail-based care” was coined during the elaboration of the General Plan of Rome approved in 2008, with the aim of making all city transformation conditional upon the presence of an urban or metropolitan rail service hub<sup>2</sup>.

Particularly remarkable is the German S-Bahn model, which has contributed to ensuring balanced accessibility across metropolitan territories, supporting functional decentralisation, fostering widespread economic development, countering social segregation, and preserving environmental qualities (Campos Venuti, 2005). For instance, in Berlin, Kunst (2016) provides a key framework for analysing urban planning and transport policies, as well as the practical interactions between urban structures and transport systems, in this context. The study seeks to understand how the planning of a new rail-based development -more sustainable and more equitably distributed- can be realised by enhancing railway stations identified as having high regenerative potential. This does not refer exclusively to major central stations -which, in various European contexts, have already undergone significant transformations in recent decades (Van Acker & Triggianese, 2021)- but rather to “intermediate stations” that may play a strategic role in the reorganisation of rail services and simultaneously support the revitalisation of the surrounding neighbourhoods. Stations are no longer seen merely as access points to the transport network; increasingly, they act as catalysts for territorial transformation, capable of generating value across multiple scales and fostering sustainable and efficient mobility systems. The role of stations -long recognised in the literature not only as nodes but also as “places” (Bertolini, 1996)- takes on different characteristics in these “in-between contexts” -neither central/urban nor peripheral/rural in the Metropolitan Cities- than in large stations or in urban areas with high settlement and functional density.

It is more complex to implement effective integrated mobility systems, but railway lines must necessarily interact with other transport networks, such as slow mobility networks or the local public transport system to guarantee accessibility to places and in particular to the network of essential services.

This contribution is part of the broader debate on suburban areas and mass rail transit, focusing on five Metropolitan Cities -Milan, Barcelona, Paris, London, and Berlin- which, although central to sustainable mobility policies, tend to overlook the role of their hinterlands (Nenseth & Røe, 2024). The analysis highlights that Metropolitan Cities function as administrative bodies capable of managing the real scale of contemporary urban areas, extending beyond municipal boundaries to include the “in-between” zones. However, as seen in the Italian case, they still overlap with the old provincial boundaries without a direct-elected major<sup>3</sup>, which limits their decision-making autonomy and their ability to effectively guide reorganisation choices in transport, settlement, and environmental protection.

The study focuses on a comparative selection of “intermediate stations”, identified on the basis of documentation provided by rail operators. From this initial assessment, further criteria are applied -such as the settlement density of the context, the type of junction and the inclusion in historic railway tracks converted for metropolitan rail service- with the aim of assessing their different degrees of regenerative potential for the existing urban fabric in which they are located. Our goal is not to compare European cities directly, but to use their variety to highlight territorial disparities -in areas like services, public transport, greenery, commerce,

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<sup>2</sup> The term “rail care” is listed among the inspiring principles of the local plan of Rome. It identifies among its strategic choices “the metropolitan dimension, the principle of sustainability, care of the railways, the qualification of the suburbs, the priority of history”, outlining a polycentric and infrastructural vision of the city. See Municipality of Rome, General Regulatory Plan - The Inspiring Principles, available at: <https://www.urbanistica.comune.roma.it/prg/principi-ispiratori.html>

<sup>3</sup> According to Law No. 56/2014, metropolitan cities are classified as second-level entities that have elected bodies chosen through indirect suffrage. This means that citizens do not vote directly for the metropolitan mayor or the metropolitan council. Instead, these positions are elected by the mayors and councillors of the municipalities that make up the metropolitan city.

and density- that lead to diverse problems and require tailored urban planning responses. Consequently, successful initiatives launched in specific contexts cannot be replicated universally by focusing only on the type of station.

This constituted the first phase of the investigation, which is followed by a more detailed analysis focusing on the areas surrounding two selected case studies. The second phase of the research focuses specifically on these two stations, which were chosen as they offer an interesting comparison: both are railway nodes with direct interchanges to metro lines. This feature is essential, as it enables an in-depth exploration of the spatial and functional integration between different levels of mass transit systems. This paper aims to demonstrate the necessity of employing the characteristics of the urban context to define the role of the "intermediate railway station," thereby guiding both the criteria for identifying railway nodes and the prioritisation of interventions. Through a comparative analysis at the European scale, the value of this research lies in its argument that the current classification of "intermediate stations" -essentially based on the role they play within the rail service and associated with different priorities for intervention and funding by railway operators- fails to reflect homogeneous territorial conditions. This results in the standardisation of projects and funding mechanisms, ultimately reducing the regenerative potential that railway nodes could offer in rebalancing settlement patterns within metropolitan contexts. The aim, therefore, is not to propose a new "scale of railway service" but rather to define the "potentially regenerative role" that these stations can play in their respective territories.

## 2. Research methodology

The methodology adopted to delineate the "intermediate stations" consists of two main phases. The first phase involves a comprehensive comparative analysis across five European cities-Barcelona, Berlin, London, Milan, and Paris-applying homogeneous parameters derived from the railway operators' documents for the selection of "intermediate stations". This analysis immediately highlighted both the varying extent and density of the railway service in the respective metropolitan areas, as well as the diversity of the urban contexts in which these infrastructures are located (Fig.1).

The second phase deepens the investigation by focusing specifically on Berlin and Barcelona. In this phase, the analysis examines the attraction basins (600-meter radius) -parameter used by several authors within the methodology of applying TOD, defined as the distance within which residents can easily access a public transport station and a range of essential services and shops within a walkable distance of 600 m (Calthorpe, 1993)- of the two most relevant railway nodes -Wittenau (Berlin) and El Prat de Llobregat (Barcelona)- to assess their accessibility and functional composition in detail. These two cities were selected as they were the only cases among the five where a direct interchange exists between the metropolitan rail systems and metro lines.

This feature was deemed essential for the second phase of our study, as it allows us to explore the spatial and functional integration between different levels of mass transport systems. This approach combines the review of existing sector documentation and scientific literature, territorial analysis, and the and a comparative study of five European cities (Barcelona, Berlin, London, Milan, and Paris) which enable an assessment of the exportability of the research results outside Italy.

In each of these cities, the following steps were carried out using the open-source GIS software QGIS:

- a GIS mapping of municipalities with a density between 1,000 and 3,000 inhabitants/ km<sup>2</sup>. This range differentiates intermediate contexts, excluding high-density hyper-compact central areas -where the demand for mobility is established- nor rural/peripheral areas -where the demand for travel is weaker- (Ciommi et al., 2020; European Commission, 2021);
- the selection of railway stations belonging to historic railway tracks, dating back to the mid-19th century, which have now been converted into railway lines for metropolitan service;

- a passenger volume of between 1,500 and 10,000 passengers/day;
- the interchange with other rail networks, either through the railway node itself or through pedestrian accessibility (within a 5-minute walk) to metropolitan or trams stops.

The identification of “intermediate stations” was based on a review of official documents provided by railway operators in the selected contexts. Although these classifications differ in their specific criteria, they serve common objectives with clear benefits for the surrounding context: improving infrastructure asset management (maintenance, investment, contract negotiation); optimising passenger experience and commercial strategies; supporting the ecological transition (energy sustainability, intermodal mobility, digitalisation); promoting stations as integrated intermodal urban hubs; and strengthening stakeholder engagement and interactions with the urban fabric (UIC, 2022). However, the classification criteria used by different operators are limited to parameters related to transport demand (e.g. daily passenger numbers, number of trains) or physical and functional characteristics of the railway facility (e.g. size, amenities, intermodality potential), while entirely neglecting the characteristics of the surrounding area. More specifically, the selection was based on the following sources:

City	Rail operator	Parameters and available data
Barcelona	ADIF (Administrador de Infraestructuras Ferroviarias)	Category 4 - stations located along the Rodalies network, selected based on the parameters mentioned above.
Berlin	DB (Deutsche Bahn)	Stations of the urban and suburban S-Bahn system, with at least 2-3 intersecting lines; classified as high-frequency local transport hubs.
London	TfL (Transport for London)	Stations of the London Overground and Elizabeth Line, classified as: C (important feeder: 0.5-2 million trips/year) D (medium staffed: 0.25-0.5 million trips/year). Annual entries and exits were verified using TfL Open Data.
Milan	RFI (Rete Ferroviaria Italiana)	Stations from the silver category (more than 2,500 daily travellers, on regional/metropolitan high-frequency lines) and some from the bronze category. Data verified using Open Data Lombardia.
Paris	SNCF (Société Nationale des Chemins de fer Français)	Stations from the RER (Réseau Express Régional) system of the Île-de-France were selected with the parameters described above. Traveller numbers verified through SNCF Open Data.

**Tab.1 Overview of selected European cities, rail operators, and available data able description**

### 3. Results of the research

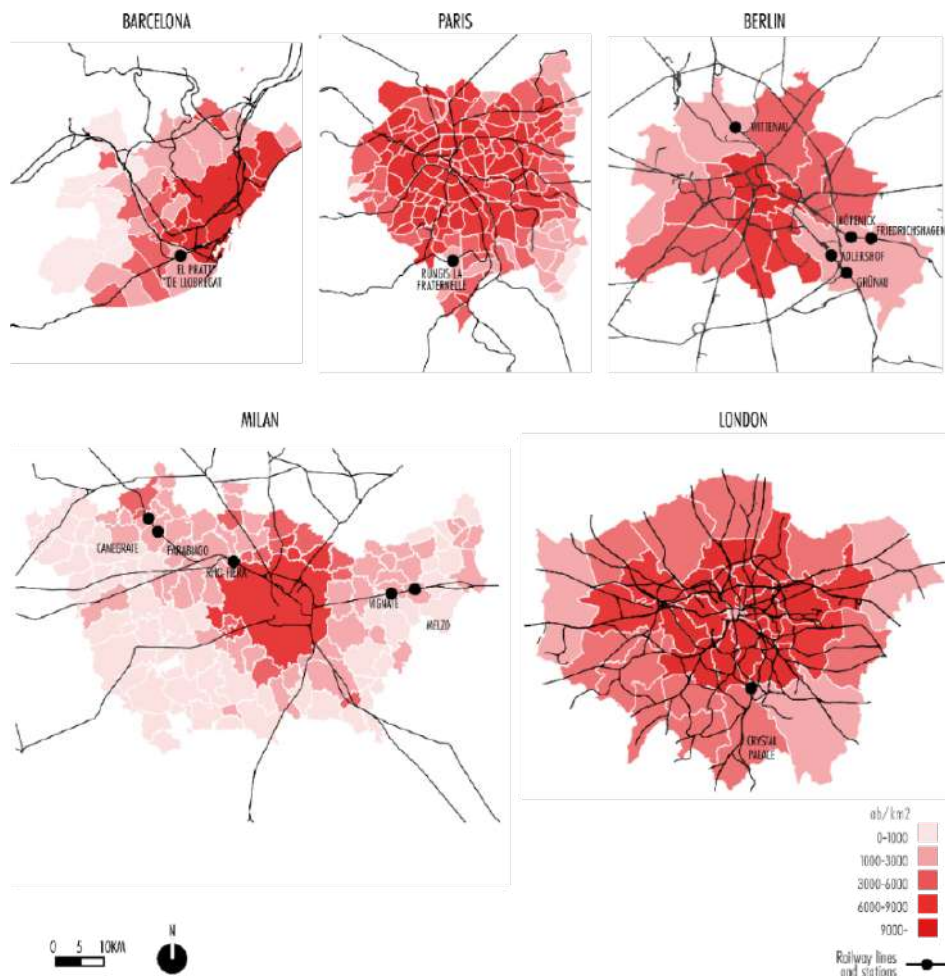
The investigation of the five case studies was developed in two distinct phases, as outlined in the methodology section. Starting from the identification of parameters that describe the scale of stations according to the services offered and their spatial location within metropolitan areas (passenger flows, service levels, intermodality, territorial accessibility), the research identifies those stations that can currently be classified as “intermediate.” However, these stations often reveal significant differences precisely in relation to their surrounding contexts. Two of these stations were selected for a more in-depth urban planning analysis of their surrounding areas, as they offer an interesting comparison: both are railway nodes with direct interchanges to metropolitan subway networks. In fact, the analysis focuses on the relationship between node and context, to understand whether - and with what functional and performance parameters - the implementation of

stations defined as intermediate with the integration of other mobility networks can then translate into concrete regenerative effects on the territory.

### 3.1 First phase: mapping "intermediate stations" in the 5 metropolitan cities

A total of 13 railway stations emerged from this first mapping phase as shown in Fig.1.

- In Barcelona's metropolitan area, the El Prat de Llobregat station stands out, located in the municipality of the same name adjacent to the Catalan capital and serving the Rodalies metropolitan railway lines (R2-R2N-R2S) and interconnected to the L9 metro line connecting the capital to its airport.
- In the Berlin metropolitan area, stations belonging to the city's S-bahn system emerged, in particular Wittenau (which interchanges with the underground U-Bahn line), Adlershof, Grünau, Friedrichshagen and Köpenick (connected by a dense tram network).
- In the Greater London area, the Crystal Palace junction emerged, a station located in the southern borough of Bromley, served by the London Overground system (Windrush Line) and regional Southern Railway lines connecting the capital to the city of Brighton and Hove.
- In the Milan metropolitan area, several stations were found along the S5 line connecting Varese to Treviglio via Milan, namely the Rho-Fiera station (which interchanges with the M1 metro line) as well as stations in Canegrate, Parabiago, Vignate and Melzo, integrated with some regional railway services.
- In Grand Paris, the selection revealed the Rungis La Fraternelle railway station, in the French municipality of Rungis, served by the RER-C suburban rail line and interconnected to the tram line 7.

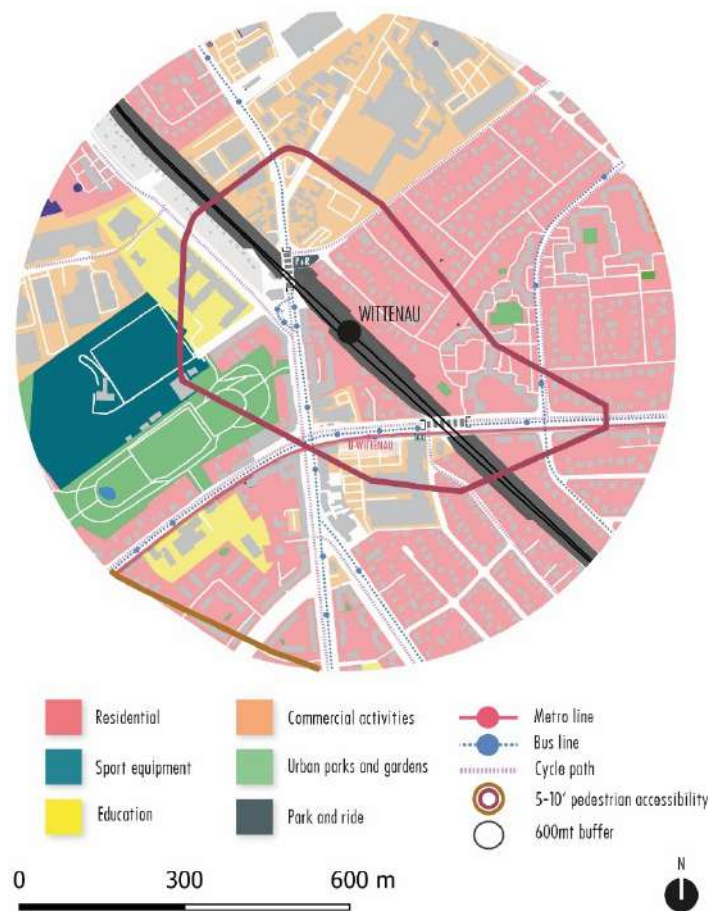


**Fig.1 Identification of railway stations in medium- and low-density municipalities belonging to European Metropolitan Cities**

### 3.2 Second phase: comparison of the areas of influence of railway stations

In the second phase, the urban structure of the contexts surrounding these “intermediate stations” was examined, envisioning how projects aimed at enhancing the railway network’s accessibility could effectively contribute to the urban regeneration of nearby neighbourhoods. The comparative analysis of station areas revealed significant differences, particularly in terms of pedestrian accessibility and the functional composition within a 600-meter radius. Focusing on two relevant cases where integration between the railway and metro lines already exists - Wittenau station in Berlin and El Prat de Llobregat station in Barcelona - the analysis was deepened to assess levels of accessibility and existing urban functions. These cases demonstrated very different regenerative potentials.

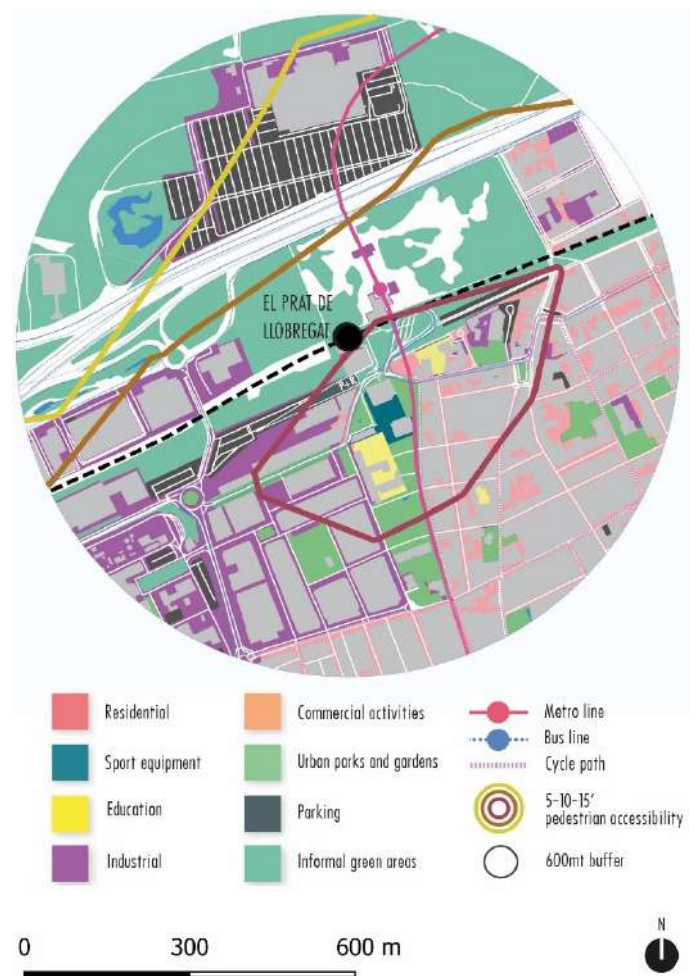
*Analysis of the Wittenau station.* Located in the northwestern quadrant of Berlin, Wittenau Station (Fig.2) functions as a strategic interchange node between the S-Bahn (line S1) and the U-Bahn (line U8). The area is characterised by high multimodal accessibility, facilitated by an extensive cycling network, a well-distributed public bus service and its stops, and a park-and-ride facility serving the railway station. These features contribute to integrating the station into the broader urban and metropolitan mobility network. From a functional perspective, residential use predominates within the buffer area; however, a notable functional mix is observed, aligning with the station’s proximity principle. Facilities related to education, sports, urban parks, green spaces, and commercial areas are present. This variety of services strengthens the station’s role as an urban hub. In conclusion, the analysis of the Wittenau node highlights how an intermediate station, located in a non-central urban context, can assume a strategic role in daily mobility.



**Fig.2 Analysis of the context of the Wittenau railway station in Berlin**

*Analysis of the El Prat de Llobregat station.* In the Spanish context, the case study focuses on El Prat de Llobregat Station (Fig.3), located in the municipality of the same name west of Barcelona. The station is served

by an underground railway line within the Rodalies metropolitan system and is connected to the metro network (pink line, L9 South). A park-and-ride facility is also located south of the station, reinforcing its potential as a strategic node for intermodal mobility. However, compared to the Berlin case, the cycling infrastructure is less widespread and not adequately connected to the station area. Pedestrian accessibility appears partially fragmented, as shown by the area under analysis: the 5- and 10-minute walking coverage is hindered by several infrastructural barriers and urban discontinuities that compromise the full usability of the public space. The urban context is strongly polarised by areas predominantly zoned for industrial use. North of the station, there are vacant and unused areas that are currently inaccessible, further delimited by the C-31 highway (Castelldefels). In contrast, the southern side contains the consolidated urban fabric, with a mix of residential, industrial, and commercial functions, along with some school facilities, green areas, and sports infrastructure. In conclusion, the El Prat de Llobregat node demonstrates that the presence of transport and interchange infrastructure does not necessarily ensure full accessibility to the station area or integration with the surrounding urban fabric. Nevertheless, the station presents high regenerative potential -both due to its underutilised spaces and its proximity to major infrastructure (such as the airport)- offering opportunities for urban reconnection and for strengthening the station's role within the urban system.



**Fig.3 Analysis of the context of the El Prat de Llobregat railway station in Barcelona**

#### 4. Conclusions

The comparative study across five European metropolitan cities showed that even when using official railway operator data and a fixed set of “intermediate station” parameters, the selected stations were actually highly diverse in their local environment. As a result, they were only hypothetically classified as stations of the same

rank, pushing us to review their regenerative power. The differences concern both the relevance of each node within the broader network and the characteristics of the urban context in which the stations are located, including the variety of land uses (functional diversity, services, quality of public space, etc.) and the levels of accessibility to the infrastructure. Therefore, it is clear that applying homogeneous quantitative criteria is not always sufficient to identify stations that actually fall into the category of intermediate railway stations. The “intermediate scale” considers not only the railway service offered, but also the regenerative potential of places “in the middle” between large cities and more dispersed areas.

A first critical consideration concerns the limitations of current railway station classification criteria. The parameters commonly used tend to focus predominantly on aspects related to passenger services or the physical characteristics of station buildings, often overlooking the potential urban centrality these nodes may acquire -particularly when intermodality is implemented in conjunction with urban regeneration processes. As a result, the classification may provide a partial reading that fails to fully capture the role these stations can play from a design and planning perspective- especially considering that their classification influences the priorities and funding strategies of railway operators.

However, the possibility of defining intermediate stations through a method that captures both the scale of the service, and the characteristic of the locational context is fundamental to effectively guiding urban regeneration processes and in particular through the implementation of intermodality and multimodality considered essential characteristics for sustainable city development.

This study opens an innovative field of exploration, while numerous research efforts have focused on high-speed rail stations -often located on the peripheries of urban centres- and examined their accessibility and socio-economic impacts (Beria et al., 2018; Bertolini, 1996, 2023; European Commission, 2021; Panuccio, 2024; Van Acker & Triggianese, 2021) far less attention has been paid to intermediate railway nodes located in areas with medium-to-low residential density; despite the fact that metropolitan (and regional) railway services - according to several studies and annual reports such as Legambiente’s *Pendolaria*<sup>4</sup>- are, at least in Italy, the most widely used by daily commuters.

Intermediate stations in relation to metropolitan railway networks therefore represent an opportunity to enhance secondary territories, integrating them into a wider mobility network and thus implementing the principles of intermodality and multimodality become potential elements to foster processes of territorial and urban regeneration, affecting both the quality of urban space and equity of access to mobility.

Railway programming and urban planning should thus converge towards strategies that recognise the multifunctionality of railway nodes, addressing the challenges posed by (suburban and peri-urban) fragmentation (Zhang et al., 2021) and embedding them in locally scaled strategies that align with territorial dynamics. It is crucial to acknowledge each station’s specificity and its relationship to the local context, implementing selective refunctionalisation strategies, through which they can take on a vocation in becoming new urban centralities, hosting public spaces, social services, and collective activities, while being integrated into a system of sustainable mobility that combines rail, local public transport, and active travel. These are key features for promoting sustainable, safe, and active mobility networks (Fior et al., 2022), and for contributing to the rethinking of individual transport modes (Velo & Munarin, 2023). A network of “intermediate stations,” interconnected among themselves and with other mobility systems, can contribute to redrawing urban and territorial hierarchies, strengthening cohesion and the quality of public space across multiple scales.

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## Image sources

Fig.1-3: Elaboration by author L. Dangelo (2025)

## Author's profile

### **Ludovica Dangelo**

Architect and PhD candidate in Territorial, Urban and Landscape Planning at Sapienza University of Rome. Her research focuses on the integration between mobility infrastructures and urban planning.

### **Marika Fior**

Urban Planner, PhD in Territorial Government, Researcher at Sapienza Università di Roma. She is involved in research with the Department of Planning, Design and Technology of Architecture. She is Executive Board Member of the Italian Association of Historic and Artistic Centers.

### **Paolo Galuzzi**

Architect, PhD, Full Professor at Sapienza Università di Roma. He is involved in research with the Department of Planning, Design and Technology of Architecture. He is member of the National Institute of Urban Planning and Director of *Urbanistica Journal*.