Beyond the Station: Multimodal Interchange Hubs in Coastal Cities for Urban Integration

Chiara Garau(✉), Francesca Maltinti, Laura Peretti, Salvatore Farci, and Mauro Coni

Department of Civil and Environmental Engineering and Architecture (DICAAR), University of Cagliari, Cagliari, Italy
cgarau@unica.it

Abstract. Railway stations are increasingly moving beyond their traditional role as mono-functional transport infrastructures and becoming complex multimodal environments, where different mobility systems intersect and where important relationships with urban space are continuously negotiated in relation to accessibility, spatial continuity, pedestrian experience, and the changing role of infrastructure within the city. The issue is particularly relevant in coastal cities, where interchange hubs are shaped not only by transport networks, but also by waterfront conditions, historic urban fabrics, and spatial constraints that are often difficult to reconcile. Starting on this perspective, this paper shows the preparatory work developed before the "Progetto-guida B.5" within the Municipal Urban Plan of Cagliari and it examines multimodal interchange hubs in selected European cities, analysing how transport efficiency, spatial hierarchy, and urban integration are connected in practice. The Cagliari railway station is used as a case study because of its role as a strategic coastal gateway, were metropolitan flows, the historic city, and the maritime edge meet without always forming a continuous urban system. The findings suggest that the "success" of a hub cannot be captured by transit metrics alone, but its effectiveness also depends on the clarity of its spatial organisation, on the readability of pedestrian routes, and on the capacity to maintain continuity across infrastructural barriers. In the case of Cagliari, the coastal station appears as a functional node and also as a possible catalyst for urban restructuring, especially in reconnecting the city's historical identity with its waterfront and future coastal development.

Keywords: Multimodal Interchange Hubs · Coastal Cities · Urban Integration · Railway Stations · Mobility Design · Waterfront Regeneration · Pedestrian Continuity · Cagliari (Italy)

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1 Introduction

Urban mobility systems increasingly shape accessibility [1–3], spatial organisation [4, 5], and also urban quality [6, 7]. Railway stations and multimodal interchange hubs can be understood as key infrastructural nodes [8], acting both as interfaces between transport modes and as points of contact with between the physical city [9]. Their role therefore goes beyond mobility performance, influencing urban connectivity, socio-spatial interactions, and the wider structure of cities.

As urban environments have become more complex, railway stations have gradually evolved from mono-functional infrastructures into integrated multimodal systems. They are now expected to accommodate different transport modes, manage diverse flows, and ensure accessibility across several spatial and functional layers. For this reason, their design must combine technical efficiency with legible spaces, ease of use, and a clear relationship with public space. However, understanding how to effectively organise these systems remains a significant challenge, particularly in contexts characterised by spatial constraints and overlapping urban functions.

Such a challenge, in coastal cities, becomes even more crucial when interchange hubs are displaced in territories negotiated by the imbalance of transport networks, waterfront dynamics port infrastructures, and an historical stratification of urban fabrics. These conditions introduce discontinuities, conflicts in pedestrian and vehicular flows, as well as challenges of spatial continuity between infrastructure and the urban space. Within such contexts, uncertainty remains about which approaches to design offer the best value in terms of transport efficiency and urban integration.

A key question that authors try to reply in this paper is if multimodal interchange hubs should be mainly designed as transport infrastructures or as urban spaces that can bridge mobility systems and city. More specifically, the question can be finalised by considering spatial organisation strategies such as hierarchical distribution systems, flow separation, and multimodal articulation in a way that can secure operational efficiency as well as urban continuity. Added to this is the issue of active mobility, because contemporary interchange hubs are expected to connect rail, bus, and metro systems, and, at the same time, they have integrate cycling infrastructure within a coherent and legible spatial framework.

Indeed, existing literature highlights the importance of spatial hierarchy, central distribution spaces, and the separation of flows in improving the functionality of complex transport environments [10], but also the role of station forecourts, pedestrian continuity, and the relationship between infrastructure and public space [11–14]. However, these perspectives are often treated separately, without a comprehensive framework that connects internal spatial organisation with external urban integration, especially in coastal cities.

This paper aims to explore this particular issue through a design-oriented perspective, focusing on the relationship between spatial hierarchy, flow separation, and urban integration. The research is based on a comparative interpretation of European contexts and on the analysis of the Cagliari railway station area as a strategic coastal node between the metropolitan system, the historic city, and the waterfront. The objective is to identify recurring spatial principles and discuss their applicability in other coastal environments.

By doing so, the paper contributes to the broader debate on multimodal interchange design by addressing the gap between transport-oriented and urban-oriented approaches and it seeks to clarify how spatial and functional strategies can support the integration of infrastructure within the urban fabric, particularly in contexts characterised by strong environmental and spatial constraints.

In Sect. 2, the conceptual framework on spatial hierarchy, flow separation, and urban integration in multimodal interchange hubs are introduced. Section 3 describes the methodology and the analytical approach adopted in the study and Sect. 4 presents the case study of the Cagliari railway station. The main findings are underlined in Sect. 5 and the conclusions are summarised in Sect. 6, highlighting implications for future research and planning practices.

2 Conceptual Framework: Multimodal Interchange and Urban Integration

The concept of multimodal interchange has progressively evolved in response to broader transformations in urban mobility systems and in the role of transport infrastructures within contemporary cities [15, 16]. Initially associated with the notion of intermodality, a term rooted primarily in freight transport and in the efficient transfer of goods between transport modes, the concept has gradually been reinterpreted in relation to passenger mobility [17, 18]. In this shift, attention has moved beyond technical transfer efficiency measured only through transport indicators, towards the spatial, functional, and experiential organisation of movement, where the quality of public space and the degree of connectivity with urban life are also central to hub performance [8, 9].

In passenger transport contexts, the term multimodal interchange hub more accurately describes a node where different mobility systems, such as rail, metro, bus, cycling, and pedestrian networks, are connected through organised transfer conditions. This broader understanding is especially important because it frames cycling not as a residual mode, but as a potentially constitutive component of interchange hierarchy and station accessibility. This distinction is not only terminological, but it marks a clear shift from the optimisation of freight logistics to the design of environments that support passenger orientation, accessibility, continuity, and ease of movement. In this sense, the multimodal hub is both a transport device and a spatial system shaped around the experience of transition.

This evolution also reflects a broader change in the literature, where stations are increasingly understood not as isolated infrastructures, but as hybrid urban places: transport nodes embedded in the wider fabric of the city. Bertolini's node-place model was particularly influential in establishing this dual interpretation, later expanded by studies emphasising value creation around stations, user experience, and the role of stations in urban restructuring [19, 20]: the performance of interchange environments can be understood through transport indicators, as well as through spatial legibility, quality of public space, and the capacity to connect infrastructure with urban life.

Within this debate, a central issue is the relationship between the station and its ***urban frontage***. This should not be understood only as the architectural façade, but as the wider system of public spaces, access points, pedestrian routes, and transitional areas

through which the station connects with the city [21]. When this interface is accessible, permeable, and spatially well designed, it improves usability and strengthens the socio-spatial value of the station area, also supporting its potential role in urban regeneration [22].

A second focal point of research focuses on how interchange environments are organised internally. In complex transport nodes, where different modes and user flows coexist, a clear spatial structure becomes extremely important to consider and in particular the **hierarchy**, in terms of circulation and of the distribution of functions.

Large interchange systems often depend on central spaces, such as atria or main halls, which help users orient themselves and move through the hub, while secondary areas accommodate specific modes and services [9, 10]. The "atrium-satellite" logic is therefore relevant as a design diagram, and as a conceptual model for understanding how complexity is spatially ordered. As shown in Fig. 1, the atrium usually acts as the main distributive space, while satellites accommodate more specific functions, such as rail access, buses, taxis, car circulation, or pedestrian connections. As stations increase in scale, this logic does not necessarily change; rather, the number and articulation of satellites tend to grow. In larger metropolitan systems, more than one atrium may also be present, each connected to its own set of satellites. Their position and relationship with the main atrium influence not only internal circulation, but also the way the station connects with the surrounding city and shapes external public spaces. This organisational principle will be further discussed through the cases of Paris, Marseille, and Madrid.

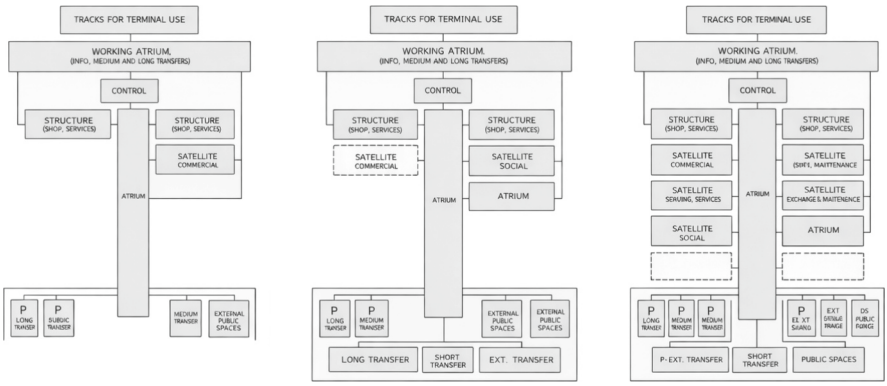


Fig. 1. Atrium–satellite hierarchy in multimodal interchange systems (Paris, Marseille, and Madrid). Source: elaboration by "LAURA PERETTI_architects"

A third important element of research is the **flow separation**. Studies on station design and interchange performance repeatedly show that the coexistence of pedestrian, vehicular, and rail-related movements generates friction when different speeds, directions, and access logics are forced into the same space [23, 24]. For this reason, the organisation of flows into differentiated levels or bands has become a recurrent strategy in contemporary multimodal hubs. Although often framed in technical terms, flow separation has strong spatial implications, since it conditions visibility, continuity, accessibility, and user perception.

A fourth issue is **urban integration**, indeed, stations perform better when they operate as extensions of the surrounding city rather than as autonomous enclaves [25–27]. This means that continuity of pedestrian space, public-space design, frontage permeability, and visual relationships with the urban context are part of interchange performance itself, particularly when passengers move within the hub, and the same hub becomes part of a broader urban system.

Building on these aforementioned statements, the present paper adopts a conceptual framework based on three interrelated analytical dimensions: **spatial hierarchy** (the differentiated organisation of interchange spaces according to role, centrality, and function, **flow separation** (the spatial and often vertical differentiation of pedestrian, vehicular, and rail-related movements), and **urban integration** (the extent to which the interchange hub establishes strong physical, functional, and visual relationships with the surrounding urban fabric). This last one includes the quality of the station frontage, the continuity of pedestrian systems, and the role of the hub in shaping public space and urban accessibility.

These three dimensions are treated in this paper as mutually dependent components of a single interpretative framework. Spatial hierarchy supports legibility, flow separation supports operational clarity and continuity and finally, urban integration supports the transformation of infrastructure into an urban interface. Their interaction provides the analytical basis for the comparative assessment developed in the following section.

3 Methodological Framework

This study adopts a qualitative comparative approach aimed at interpreting multimodal interchange hubs through the analytical dimensions defined in Sect. 2. The methodology is structured in two main components: the analysis of selected European precedents (paragraph 3.1) and the application of the resulting framework to a specific case study (paragraph 4). The objective is not to identify a universal model, but to understand why certain choices worked, as well as to recognise the recurring spatial logics and evaluate their applicability in complex urban contexts.

3.1 Comparative Analyses of Selected European Multimodal Interchange Hubs (Paris, Marseille, Groningen, and Madrid)

In this paragraph, selected case studies are analysed in order to understand different spatial responses to hierarchy, flow separation, and urban integration. The comparative analysis focuses on four European multimodal interchange hubs: Paris Gare de Lyon, Marseille Saint-Charles, Groningen, and Madrid Puerta de Atocha.

Paris Gare de Lyon offers a significant example of a multilayered terminal interchange, where spatial hierarchy, pedestrian continuity, and differentiated urban frontages are closely connected. The station is organised as a distributed system, with tracks located at an upper level, major access halls, and external public spaces that establish direct relationships with the urban fabric. As shown in the aerial views, the interchange is not concentrated in a single node, but articulated through a sequence of spatial devices linking the railway body, the atria, and the adjacent plazas (Fig. 2).

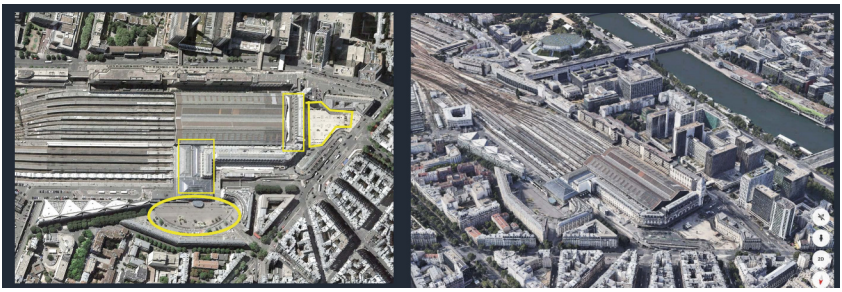


Fig. 2. Paris Gare de Lyon: aerial view of the terminal station, highlighting the two main atria and the principal external spaces of pedestrian access. Source: elaboration by "LAURA PERETTI_architects"



Fig. 3. Paris Gare de Lyon: interior views of the two main atria, showing their role in pedestrian distribution and vertical connection between station levels. Source: elaboration by "LAURA PERETTI_architects"

A central feature of the case is the role of the two main atria. These spaces function as the primary devices for pedestrian distribution and level transition, allowing users to move between the railway platforms, the city level, and the interchange services without compromising overall legibility. In this sense, the atria are not simply interior halls, but key elements in the hierarchical structure of the station, since they connect different levels while preserving continuity with the urban realm (Fig. 3). This case is also significant for the treatment of external public space. On the north-eastern side, pedestrian flows open onto a protected plaza system, while vehicular movement is canalised along dedicated and uninterrupted routes. This arrangement preserves the continuity of pedestrian space and avoids direct interference between pedestrians exiting the station and cars moving through the frontage, demonstrating how surface-level accessibility may be organised through a principle of dominant pedestrian continuity (Fig. 4).

On the south-western side, local traffic, bus services, cycling routes, and pedestrian areas coexist within the same urban edge. However, the case shows that coexistence does not necessarily mean spatial overlap. Each mobility system occupies a recognisable and distinct area, while the urban bus component is positioned laterally rather than directly in front of the main station frontage. This produces an interface that is more articulated than the north-eastern side, but still governed by clear separation between functions



Fig. 4. Paris Gare de Lyon: north-eastern station frontage, characterised by uninterrupted pedestrian and vehicular flows, organised through a clear spatial separation between welcoming pedestrian spaces and predominant, largely monofunctional car circulation and parking systems. Source: elaboration by "LAURA PERETTI_architects"

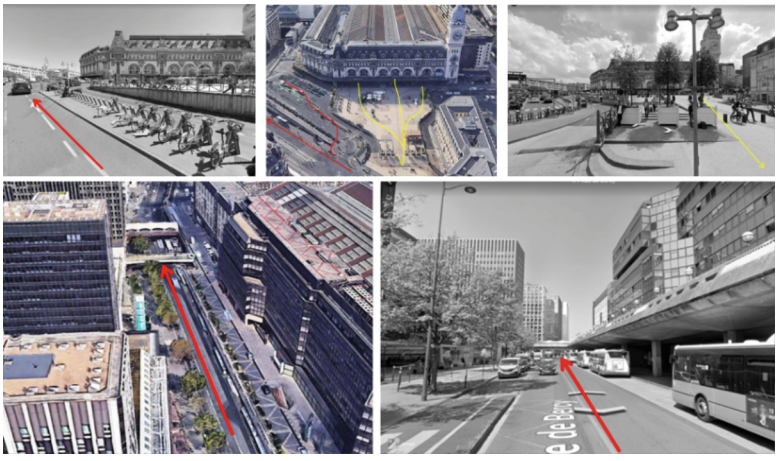


Fig. 5. Paris Gare de Lyon: south-western station frontage and right-hand side, characterised by cycle-pedestrian flows, welcoming public squares, and bus departure areas, with local neighbourhood traffic running longitudinally at city level and public space organised through clearly separated zones to avoid conflicts between vehicular circulation and pedestrians exiting the interchange hub. Source: elaboration by "LAURA PERETTI_architects"

and by readable transitions between modes (Fig. 5). The internal logic of the Paris case is further clarified by the schematic material representing the so-called "track model", where pedestrian, rail, and vehicular/bus flows are organised in distinct bands and across differentiated levels. In this configuration, flow separation is not a secondary technical solution, but the spatial principle that structures the station as a whole.

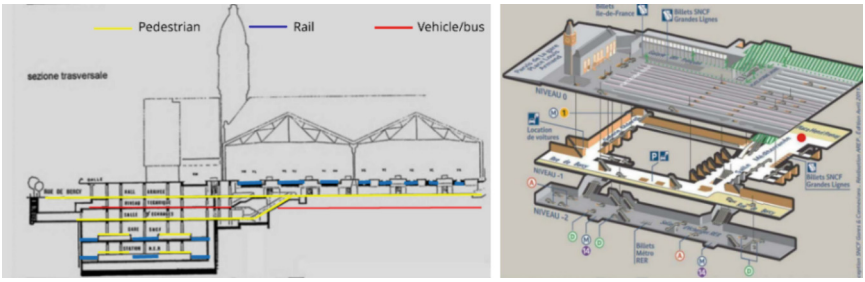


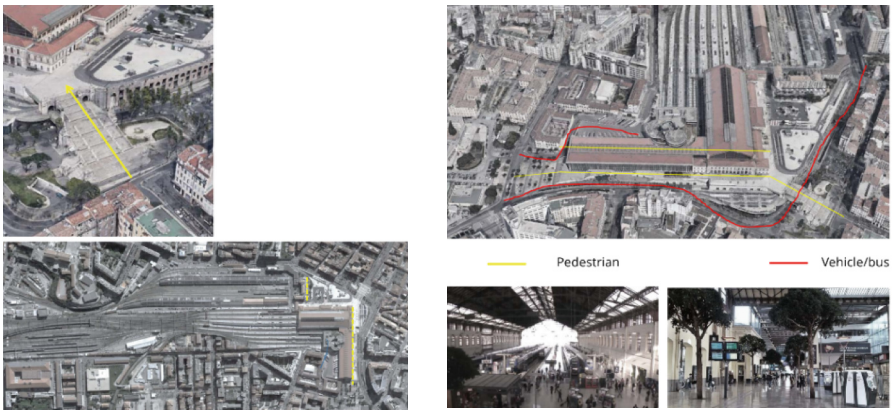
Fig. 6. Paris Gare de Lyon: a "track-based" model structures the entire station layout, with pedestrian, vehicular, and rail flows systematically ordered and separated into vertically organised, largely monofunctional bands, while the station halls play a fundamental role in reinforcing this hierarchy and mediating the relationship with the city. Source: elaboration by "LAURA PERETTI_architects"

The atria are essential to this system because they maintain hierarchical coherence and mediate between the different layers of movement (Fig. 6). A further aspect concerns the vertical allocation of parking and service functions. At Gare de Lyon, parking is positioned below the main station level, using the difference in height between the railway and the city to free the surface for predominantly pedestrian uses. This confirms that the quality of the station frontage depends not only on its formal design, but also on the capacity to move conflicting functions away from the main public interface. Paris Gare de Lyon is therefore significant because it shows how a large terminal station can work through a coordinated system of atria, differentiated frontages, layered circulation, and strong pedestrian continuity. In this case, spatial hierarchy and flow separation clearly support urban integration within a dense interchange environment.

Marseille Saint-Charles, instead, is especially relevant for understanding the relationship between interchange design and urban topography. Located above the city, the station has developed through successive phases of expansion and repositioning, combining historical and more recent components within a multilayered system. Rather than treating topographical difference as a barrier, the station transforms it into an organising principle through terraces, monumental stairs, vertical circulation devices, and distributed access spaces (Fig. 7.a).

A key feature of the Marseille case is that the principal atrium is located at the same level as the tracks, while a long lateral hall extends toward the city as a predominantly pedestrian space. The hall operates not merely as an internal corridor, but as an urbanised distribution environment, almost a protected boulevard, capable of managing both rail passengers and the arrival of extra-urban coach services. In this sense, the station frontage is not limited to an entrance façade, but unfolds as a linear public interface between the rail system and the city (Fig. 7.b).

The external terraces are central to this arrangement, as they absorb the height difference between the station and the city while creating visual and functional continuity with the urban fabric below. Together with ramps and vertical connections, they give Marseille Saint-Charles a strong landmark quality without compromising the legibility



a. Aerial view and its relationship with the surrounding urban fabric

b. Atrium at track level and long lateral hall as a pedestrian urban frontage.

Fig. 7. Marseille Saint-Charles: Multilevel terminal station. Source: elaboration by "LAURA PERETTI_architects"

of flows. The case also shows how an elevated terminal station can work both as a transport node and as an urban threshold. By placing parking and service functions below the public surface, the upper levels can remain largely dedicated to pedestrian continuity and the quality of public space. In this way, the Marseille case demonstrates that multilevel organisation can support both operational efficiency and urban integration, provided that the hierarchy of spaces remains clear and the pedestrian system remains dominant(Fig. 8).

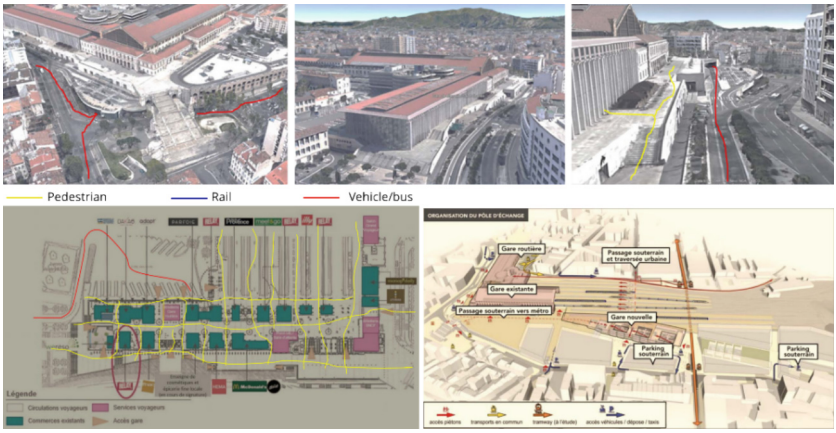


Fig. 8. Marseille Saint-Charles: terraces, vertical circulation, and sub-surface service organisation in the multilevel interchange system. Source: elaboration by "LAURA PERETTI_architects"

Analytically, Marseille is important because it demonstrates four interrelated conditions: the use of topography as an infrastructural resource; the effectiveness of an atrium

located at track level; the role of the hall as an urban frontage rather than a residual corridor; and the capacity of terraces and vertical circulation devices to transform level changes into a coherent public-space system.

Groningen offers a specific contribution with regard to cycling integration. Unlike the other cases, it foregrounds bicycle infrastructure not as a secondary or residual function, but as a structurally integrated component of the interchange system (Fig. 9).

The case is therefore especially relevant in extending the comparative framework beyond the conventional railway-bus-pedestrian triad and in demonstrating how non-motorised mobility can be incorporated into multimodal hubs through dedicated, recognisable, and autonomous spatial devices. In Groningen, cycling is not appended to the station as an accessory service, but spatially embedded within the overall interchange logic. Access, storage, and circulation related to bicycle mobility are organised through clearly identifiable areas that maintain direct connections with the main station system while avoiding interference with the principal pedestrian flows.



Fig. 9. Groningen station area: transformation of the surroundings into a dynamic urban zone centred on the 19th-century railway station (Source: [28]) Source: elaboration by "LAURA PERETTI_architects"

This makes the case particularly useful in showing that multimodal integration does not only concern the coexistence of motorised systems, but also the capacity to provide infrastructural dignity to active mobility. A second relevant aspect concerns the compactness of the configuration. Compared with larger and more monumental cases, Groningen shows that multimodal effectiveness can also depend on a compact but clearly organised spatial structure. Its value lies in the legibility of modal relationships and in the precise position assigned to each component within the overall hierarchy. In this sense, the cycling system can be read as a specialised satellite, directly connected to the station core but able to function autonomously. This broadens the idea of multimodal hierarchy beyond rail and bus systems and highlights the need to give active mobility a dedicated and recognisable role.

Analytically, Groningen is important because it demonstrates four interrelated conditions: the structural integration of cycling within the interchange system; the effectiveness of compact yet legible modal organisation; the role of dedicated bicycle infrastructure as a specialised satellite; and the capacity of non-motorised mobility to become a constitutive, rather than residual, component of multimodal hierarchy. In comparative terms, Groningen is important not because of monumental scale, but because it demonstrates that multimodal effectiveness may also depend on the integration of active mobility within a compact and highly legible interchange structure.

Madrid Puerta de Atocha represents a significant case of transformation and adaptive reuse. The redevelopment combines layered spatial organisation with the refunctionalisation of the former station building, which becomes a major public interior rather than an obsolete railway structure. The case is especially relevant for the way it distributes flows through sequences of spaces, satellites, and transitional devices, while maintaining the overall legibility of the interchange. A key aspect is the reuse of the former station as a large central public interior. Rather than being left at the margins of the new infrastructure, the historic building becomes a major pedestrian space, supporting movement, orientation, and waiting functions. This shows how adaptive reuse can strengthen the hierarchy of a multimodal hub instead of weakening it (Fig. 10a). A second important feature is the organisation of pedestrian systems across different levels. The material shows that Madrid does not rely on a single monumental connector, but on a distributed sequence of spaces and devices, including the circular interchange element that operates as a compact atrium-satellite. This relatively small but strategically positioned component resolves vertical transitions between subsurface levels and the city plane without compromising the separation between pedestrian and vehicular movement. In this respect, the case confirms the role of distributed hierarchy and compact connectors within large-scale interchange systems (Fig. 10b).

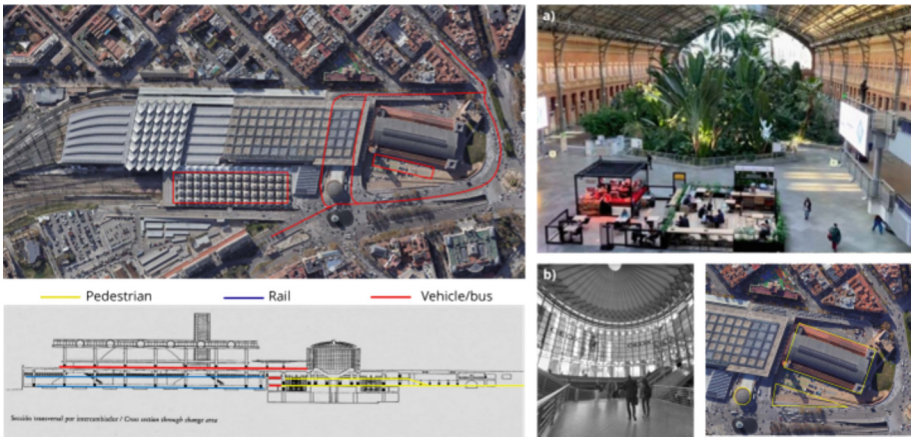


Fig. 10. Madrid Puerta de Atocha: (a) former station reused as a large public atrium and pedestrian interior; (b) circular atrium-satellite organising multilevel pedestrian movement and vertical transition between subsurface interchange spaces and the city plane. Source: elaboration by "LAURA PERETTI_architects"

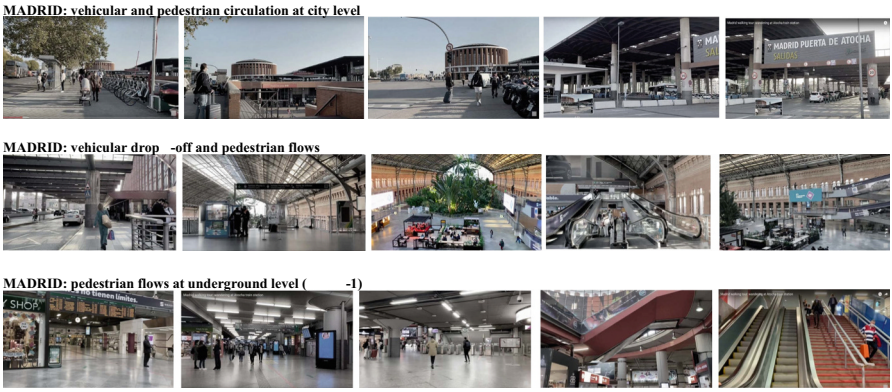


Fig. 11. Madrid Puerta de Atocha: differentiated pedestrian and vehicular systems across city level and subsurface interchange spaces. Source: elaboration by "LAURA PERETTI_architects"

The case is also particularly valuable for the clear differentiation between pedestrian and vehicular systems at city level and below it. Surface circulation, drop-off areas, and internal pedestrian sequences are organised so that overlap is minimised and transitions remain legible. At the same time, the coexistence of reused historical space and new transport infrastructure demonstrates that spatial continuity can be maintained even in highly transformed and enlarged station environments (Fig. 11).

Table 1. Multimodal Interchange Comparison

Case study	Rail level	Atrium / main distribution spaces	Pedestrian levels and connections	Cycling and micromobility	Parking system	Urban bus system	Regional / extra-urban bus system	Metro / rapid transit
Paris Gare de Lyon	+1 elevated	Multiple atria (multilevel)	0.00 city level; −1; (−2), (−3) functional	0.00 city level	Limited at grade; −1	0.00 city level (SW side, longitudinal)	Absorbed by RER and regional metro	−2; −3
Marseille Saint-Charles	+3 elevated	+3 (atrium at track level)	+3; +2	At grade	At grade; −1; −2	+2	+2	−2; −3
Madrid Puerta de Atocha	+1 elevated	−1 (tropical hall); 0.00 city level (bus atrium)	0.00 city level; −1	0.00 city level; −1	At grade; +1; −1	At grade	At grade	−2
Groningen	0.00 at grade	Main hall + cycling satellite	0.00 city level; direct connections	Dedicated cycling level and storage	Limited at grade; peripheral	At grade, integrated but separated	At grade	No metro

Madrid Puerta de Atocha is analytically relevant because it shows how adaptive reuse, distributed hierarchy, compact atrium-satellite devices, and layered circulation

can work together within a complex interchange environment. The case demonstrates that even a highly transformed station can preserve clarity and continuity when historic spaces, large passenger flows, vertical transitions, and modal connections are organised within a coherent spatial structure.

Taken together, the selected cases are interpreted through the three analytical dimensions introduced in Sect. 2: spatial hierarchy, flow separation, and urban integration. Rather than focusing on performance indicators, the comparative reading examines how each precedent organises circulation, structures relationships between modes, and defines its interface with the surrounding urban context.

Across the cases, a set of recurring spatial conditions emerges: the central role of atria or major halls in structuring hierarchy; the systematic separation of incompatible flows through levels and monofunctional bands; the use of vertical organisation to absorb complexity; and the transformation of the station frontage into an active urban interface. These conditions are not dependent on scale or form alone, but on the coherence between spatial organisation and modal articulation. At the same time, the comparison shows that these principles are not directly transferable as fixed solutions. Their effectiveness depends on the capacity to adapt them to specific urban conditions, including spatial constraints, topographical differences, and infrastructural discontinuities. Table 1 shows the comparison between the four stations analysed.

The relevance of the comparative analysis lies not in identifying ideal models, but in constructing an interpretative framework that can be tested in more complex and constrained environments. This is precisely the rationale for introducing, in the following section, a coastal case study characterised by strong spatial limitations and by a critical relationship between transport infrastructure and urban continuity.

4 Case Study: The Cagliari Station Area as a Coastal Interchange Node

Following the comparative analysis, the study focuses on the Cagliari railway station area to test the conceptual framework in a constrained coastal context. The site is located between the metropolitan mobility system, the historic city, and the port waterfront [29, 30], making it a particularly relevant case for examining spatial hierarchy, flow separation, and urban integration (Fig. 12). Its complexity derives from several overlapping conditions: limited space, proximity to the waterfront and port infrastructures, a historically stratified urban fabric, archaeological sensitivity, reclaimed land, and fragmented property arrangements. These factors create discontinuities between infrastructure and urban space and reduce the possibility of applying standardised interchange solutions.

For these reasons, the Cagliari station area is not used simply as an illustrative example, but as a critical test case. It allows to assess how the principles identified in the comparative analysis can be applied, adapted, or reinterpreted in a coastal environment marked by constraint, discontinuity, and strong infrastructural pressure.

From an analytical perspective, Cagliari is significant because it brings together, within a limited area, many of the tensions identified in the comparative framework: a weakly legible spatial hierarchy, partial overlap between pedestrian and vehicular flows, and discontinuity between the station frontage, Via Roma, and the waterfront. At the

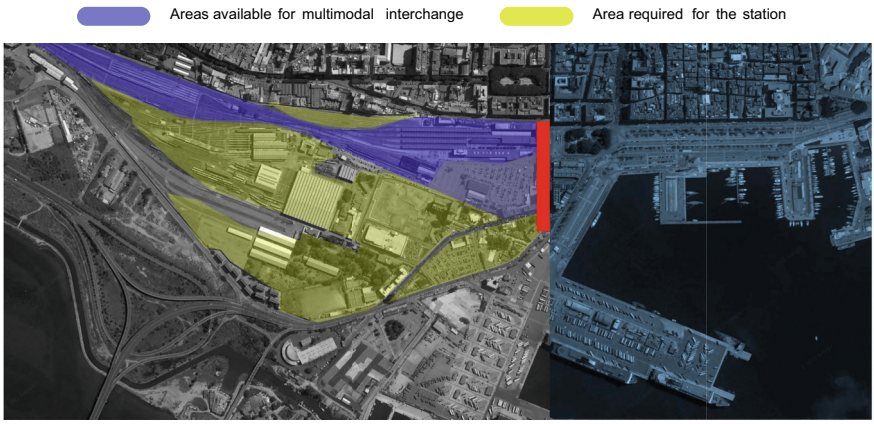


Fig. 12. The Cagliari station area between metropolitan access and historic urban structure. Source: elaboration by "LAURA PERETTI_architects"

same time, its position gives the station a strong latent potential as a gateway between metropolitan mobility, the historic fabric, and the seafront. This potential is limited by several site-specific constraints, including archaeological sensitivity, reclaimed land, the historical shoreline, and fragmented property and infrastructural arrangements. For this reason, Cagliari is not relevant because it replicates the international precedents, but because it tests how their principles can be adapted under more constrained coastal conditions.

The case suggests that an effective reorganisation would require a clearer hierarchical structure, centred on a dominant pedestrian interchange space at city level; a better redistribution of incompatible flows, possibly through differentiated or vertical arrangements; and stronger physical and visual continuity between the station, public space, and the waterfront. Cycling and micromobility should also be treated as dedicated and connected components of the interchange system, rather than as residual surface functions.

Seen in this way, the Cagliari station area does not yet fully operate as a multimodal interchange hub. However, its spatial position and structural conditions make it a critical site for redefinition. These analytical considerations may also be understood as preliminary to the broader study of the Cagliari station-port area, which in the Progetto-guida B.5 is framed as a strategic urban transformation zone aimed at reconnecting the historic city, the waterfront, and the intermodal node through a new covered atrium, improved permeability from Via Roma, reorganised bus facilities, and a wider transition toward a "15-min district".

Within the conceptual framework adopted in this paper, urban integration is interpreted as the capacity of the station to operate as a gateway between different urban systems. In this sense, the Cagliari case highlights the need to redefine the station not only as a transport node, but as a spatial interface capable of connecting metropolitan accessibility with local urban continuity and the waterfront.

This requires the construction of a continuous pedestrian system, the strengthening of the station frontage, and the establishment of clear visual and physical connections between the station and its surroundings.

When considered together, the three analytical dimensions reveal that the main issue is not the presence or absence of specific infrastructural elements, but the lack of an integrated spatial logic capable of coordinating them.

The Cagliari station area does not yet fully operate as a multimodal interchange hub in the sense defined in this paper. However, its spatial position and structural conditions offer a significant opportunity for redefinition. At the same time, the case acquires additional relevance because these analyses may be read as preliminary to a broader strategic reflection on the station-port area, where the intermodal node is already conceived, at the project-guide level, as a central device for reconnecting the historic city, the waterfront, and the wider metropolitan system.

The analysis suggests that the station can be interpreted as a **coastal gateway** if spatial hierarchy, flow separation, and urban integration are addressed simultaneously. This implies moving from a fragmented configuration to a coordinated system in which internal organisation and external relationships are conceived as part of the same spatial structure. This interpretation provides the basis for the discussion developed in the following section, where the implications of the analysis are generalised and related back to the research questions introduced at the beginning of the paper.

5 Discussion: Multimodal Interchange Between Spatial Organisation and Urban Interface

The comparative analysis and the Cagliari case study make it possible to return to the initial research questions, particularly the relationship between transport efficiency, spatial organisation, and urban integration. The findings show that multimodal interchange hubs cannot be understood only as transport infrastructures, nor simply as urban spaces. They work as hybrid systems, where operational performance and spatial quality are closely connected. In this sense, the node-place relationship should not be read as a contrast, but as a condition that needs to be spatially organised.

A central result concerns the combined role of **spatial hierarchy, flow separation, and urban integration**. In fact, hierarchy supports orientation and legibility, while flow separation helps manage pedestrian, vehicular, and rail movements more safely and efficiently. However, separation alone is not sufficient: if it is not supported by accessible and continuous connections, it can create new discontinuities and weaken integration. Urban integration is therefore essential, especially when stations are expected to work as extensions of the city rather than as isolated infrastructures.

The Cagliari case confirms this point in a particularly constrained coastal context. Unlike the comparative precedents, it operates within a dense system of spatial, historical, infrastructural, and environmental limitations. For this reason, the principles identified in the analysis cannot be applied as fixed models, but must be adapted as flexible strategies. The station can therefore be interpreted as a **gateway**, linking metropolitan accessibility, the historic urban fabric, and the waterfront.

The station can operate as a threshold between different urban systems, linking metropolitan accessibility, local urban structure, and the waterfront. This interpretation provides a more comprehensive understanding of interchange hubs, particularly in contexts where spatial discontinuities are more pronounced. These findings contribute to the ongoing debate on multimodal interchange design by emphasising the need for integrated analytical frameworks capable of bridging transport and urban perspectives.

6 Conclusions

This paper has analysed selected case studies of railway stations and has shown that multimodal interchange hubs cannot be understood only as transport infrastructures. The cases examined highlight three main aspects: spatial hierarchy is essential to make complex systems legible; flow separation helps organise pedestrian, vehicular, rail, bus, and cycling movements without unnecessary conflicts; and urban integration is what allows the station to work as part of the city rather than as an isolated node. Taken together, these elements show that the effectiveness of an interchange hub depends not only on transport performance, but on the way space is structured to support movement, orientation, and continuity with the surrounding urban fabric.

The Cagliari case confirms the relevance of this approach in a coastal context, where the station area is shaped by spatial constraints, historical layers, port-related infrastructures, and discontinuities between the city and the waterfront. In this sense, the station can be read as a gateway between metropolitan accessibility, the historic city, and the maritime edge. This work also operated as a preliminary analytical step for the broader reflection later developed in the Progetto-guida B.5, where the station-port area is framed as a strategic urban transformation zone aimed at reconnecting the historic city, the waterfront, and the intermodal node through a new covered atrium, improved permeability from Via Roma, reorganised bus facilities, and a wider transition toward a“15-min district”. Overall, the paper contributes to the debate on multimodal interchange design by emphasising the need for integrated and context-sensitive approaches. Future research may extend this framework through quantitative analyses and by testing its applicability across different urban conditions.

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