ASSOCIAZIONE ITALIANA per l'INGEGNERIA del TRAFFICO e dei TRASPORTI
Giordano Editore

Integrated model for walkability and bikeability assessment around railway stations. Pilot application on Val D'Ala, Rome

Ivan Blečić[1], Barbara Caselli[2*], Assunta Errico[3], Lea Jeanne Marinelli[2], Serena Martini[3], Italo Meloni[1], Matteo Mocci[1], Francesco Piras[1], Chiara Ravagnan[3], Eleonora Sottile[1], Giovanni Tedeschi[2]

[1] *University of Cagliari, Dep. of Civil, Environmental and Architecture Engineering, Italy*
[2] *University of Parma, Dep. of Engineering and Architecture, Italy*
[3] *Italferr – Gruppo Ferrovie dello Stato Italiane, Rome, Italy*

Abstract

Walkability and bikeability are recognised as primary factors in promoting active mobility, acting as foundational principles in contemporary urban planning. These factors may become crucial for the improvement of sustainable accessibility to strategic urban areas, such as railway stations. The node-place dual nature of railway stations generally makes these sites and their urban surroundings highly competitive centralities, especially in metropolitan areas, as they express a high 'enabling potential', thus attracting investment for regeneration purposes. Although the literature offers various methodologies for the study and evaluation accessibility, walkability and bikeability, there is still a lack of a consolidated, widely adopted and interdisciplinary approach that allows systematic and comparative analyses in the gravitation area of railway stations. This paper presents the first results of research developed in the framework of the Italian Sustainable Mobility Centre (CNMS), involving academic and business partners, aimed at filling the gap and developing a systematic suite of methods, indices and tools, for supporting sustainability assessment of regeneration projects related to train station areas in metropolitan contexts. The workflow of the methodological approach, based on GIS analysis techniques, audit protocols, machine learning and behavioral choice modelling, is presented together with an experimental application on the case study of Val D'Ala in Rome. The outcomes are expected to both refine scientific and technical knowledge and improve business procedures.

Keywords: accessibility, walkability, bikeability, railway station, assessment model, sustainable urban and transport planning.

1. Introduction

Improving active mobility within urban settlements has emerged as a core objective of European strategies for achieving decarbonisation, enhancing urban resilience, and promoting quality of life. This includes not only environmental benefits, but also impacts

* Corresponding author: Barbara Caselli (barbara.caselli@unipr.it)

on psycho-physical well-being, spatial equity, and the liveability of public spaces (Gehl, 2010). In recent years, the focus of planning and research has shifted towards integrated approaches that evaluate not only the level-of-service of pedestrian, cycling and public transport infrastructures, but also the broader urban conditions that influence mobility behaviours across different social groups (Khisty, 1994).

In this context, walkability and cyclability – along with the quality of urban space – are increasingly recognised as fundamental dimensions in assessing urban capabilities and guiding mobility choices (Vale et al., 2016). Growing attention from scholars and practitioners has highlighted the need for accessible, open, and flexible tools that support systematic assessment and comparison of walkability and bikeability across diverse urban contexts.

Among the most strategic areas for the development of active mobility are railway station surroundings (Papa & Bertolini, 2015; Carra & Ventura, 2020). In metropolitan contexts, railway stations typically display a dual nature: they function simultaneously as "nodes" in the mobility network and as "places" of social aggregation, offering access to services, opportunities, and public life (Bertolini, 1996). This complexity makes them critical focal points in urban and spatial planning. Their 'enabling potential' in expanding urban opportunities also through the integration of different modes of transport, generally acts as a catalyst for regeneration interventions attentive to issues of mobility, accessibility and urban quality. Ensuring high levels of walkability and cyclability in station areas – particularly in terms of spatial continuity, safety, and equity of access – thus becomes a significant challenge for both planning and design (Forsyth & Krizek, 2011). Addressing this challenge calls for integrated approaches capable of capturing the spatial and functional dynamics of these complex urban environments.

While scientific literature provides a wide range of methods to study and evaluate accessibility, walkability and bikeability, there remains a lack of consolidated, interdisciplinary approaches capable of supporting systematic and comparative assessments in the specific gravitational zones of railway stations. Bridging this gap requires building upon two decades of scholarly contributions to formalise structured and operational procedures that can be applied across diverse contexts. At the same time, new opportunities arise from the increasing availability of detailed spatial datasets and the rapid advancement of digital and computational tools, including GIS-based analysis and machine learning techniques.

This paper presents the outcomes of an ongoing research effort developed within the framework of the "Sustainable Mobility Centre" – CNMS (Centro Nazionale per la Mobilità Sostenibile), specifically within Spoke 9 – Task 3.2 "Platform for assessing active mobility". The research tries to fill the highlighted gap and involves collaboration between academic partners, which integrates experts in urban and transport planning, and the Italian business partner Italferr, which is engaged in the sustainability evaluation of railway stations' planning and redevelopment projects.

The objective is to develop and test an integrated methodology and interoperable toolkit for supporting urban planning and design processes in station areas. This includes the design and application of a set of indices, which aims to support sustainability-oriented decision-making through an open, flexible, and customisable assessment approach. The platform is intended to support a range of research, planning and evaluation purposes by allowing the adaptation of criteria and modelling parameters to specific urban contexts and policy goals.

The following section presents an essential literature review concerning accessibility evaluation around railway stations and consolidated methods for accessibility, walkability and bikeability assessment; Section 3 introduces the integrated methodological framework developed within the research infrastructure, the application of which to the Val D'Ala case study is presented in Section 4. Finally, Section 5 collects a discussion about the outcomes and offers some concluding remarks and perspectives for future developments.

2. Research scope and essential literature review

2.1 Accessibility evaluation around railway stations

In the framework of the research proposal defined by the Universities of Cagliari (WP Leader) and Parma (task leader), starting with the mission of the business partner and its Sustainability Unit, the research demand was oriented and guided by some methodological references linked to an integrated urban planning/infrastructure approach, in order to innovate the design of stations:

- Integration of analysis framework and data sources for data collection and synergy between design levels.
- Integrated strategies on urban mobility spaces, overcoming the sectoral vision of infrastructures.
- Sustainable intermodal scenarios based on the integrated planning of networks and services.
- Partnership processes and tools on complex urban nodes.

Infrastructure is sustainable when it considers economic efficiency (employment and economic growth), environmental effects (impact, emissions, resource and waste management) and social impact (inclusion, health, transparency and responsibility). In particular, the area surrounding railway stations is identified as a key focus for both research and intervention. It offers significant potential for promoting the combined use of rail transport and active mobility—a synergy considered essential to strengthening sustainable mobility by reducing pollutant emissions, lowering transport costs and road congestion, and improving public health and safety.

The main goal is to support the activities of the Sustainability Unit, which develops methodologies and protocols for sustainability in infrastructure design. This work takes place within research programs and working groups focused on sustainable planning, and includes the production of analyses, studies, sustainability reports, and expert contributions to multi-criteria evaluations. In particular:

- Within the Docfap (Italian acronym for ‘Feasibility Document of Design Alternatives’), the evaluation of the stations is part of the evaluation of the location and intervention alternatives with different levels of accessibility and attractiveness of the context through contribution in the Sustainability Analysis.
- Within the Technical-economic feasibility plans, the evaluation concerns the benefits of the planned interventions such as lobbies, platforms, underpasses, elevators, squares, parking lots.
- Within the Sustainability Studies, the evaluation involves the opportunities for shared projects and Memorandums of understanding.

The research path has, thus, carried out the involvement of internal design units and business partners (clients) to share the methodology and facilitate future collaborations and implementation of the tools.

2.2 Consolidated assessment methods

The assessment of walkability, bikeability, and accessibility in urban contexts has become central in both transport and urban planning studies, as active mobility is increasingly recognised as a key dimension of urban sustainability. A wide range of methodologies have emerged, rooted in spatial analysis and infrastructure-based assessment approaches, each addressing different but often complementary dimensions of pedestrian and cyclist experience in urban space.

Spatial-based approaches typically rely on GIS-based indicators that measure the distribution and connectivity of urban opportunities. These methods assess the ease of reaching destinations through active modes, often through metrics such as proximity, and service coverage (Lanza et al., 2023; Gaglione et al., 2019). Recent developments in this field also include the integration of land use mix, urban block size, intersection density, and slope, enabling a more comprehensive description of built environment characteristics (Handy et al., 2002; Southworth, 2005; Trolese et al., 2023). The application of Space Syntax theory has further enriched spatial-based studies, especially in evaluating pedestrian flows and movement potentials based on street network configuration (Garau et al., 2024).

Infrastructure-based approaches, on the other hand, have focused more on the quality and availability of physical elements and mobility services, such as sidewalks, bike lanes, crossing facilities, and public transport intermodality (Blečić et al., 2015; Caselli et al., 2021a; Torrisi et al., 2025). Audit protocols, multi-criteria evaluation frameworks (Manaugh & El-Geneidy, 2011; Caselli et al., 2021b) and behavioral models (see section 3.3) have been widely adopted to assess the performance of pedestrian and cycling environments based on on-site observations or user feedback. These frameworks often consider perceived safety, comfort, attractiveness, and inclusiveness of public spaces, capturing qualitative dimensions not directly inferable from spatial data alone.

An emerging strand of research incorporates big data, remote sensing, and machine learning to enhance both the scale and resolution of accessibility evaluation, responding to the increasing demand for dynamic, data-rich, and scalable tools (Yang et al., 2024).

These methodological advances are particularly relevant in complex, multifunctional urban contexts such as railway station areas, where the overlapping of mobility infrastructure, urban services, and social practices requires robust, interdisciplinary, and flexible evaluation models.

3. Integrated methodological framework: from audit tools to predictive modelling

The methodological approach developed is structured as a multi-level and modular workflow, integrating different analytical dimensions and methodologies. This allows for both scalable implementation and interoperability of tools, depending on the context and data availability. The framework integrates three main components, whose methodologies, expected results and relations are described in fig. 1 and following sub-sections.

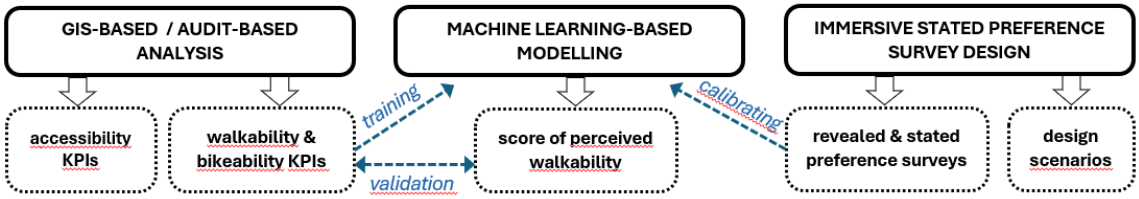

Figure 1: Integrated methodological framework and workflow.
Source: Authors' elaboration

3.1 GIS-based and audit-based analysis

This section presents the integrated GIS-based micro-scale data collection protocol, which combines geospatial analysis with on-site audits to provide a comprehensive framework for assessing accessibility, walkability and cyclability conditions. The methodology is based on georeferenced datasets that can be continuously updated, ensuring adaptability, replicability, and transferability across diverse urban contexts. The GIS-based evaluation follows three interrelated methodological steps (Fig. 2).

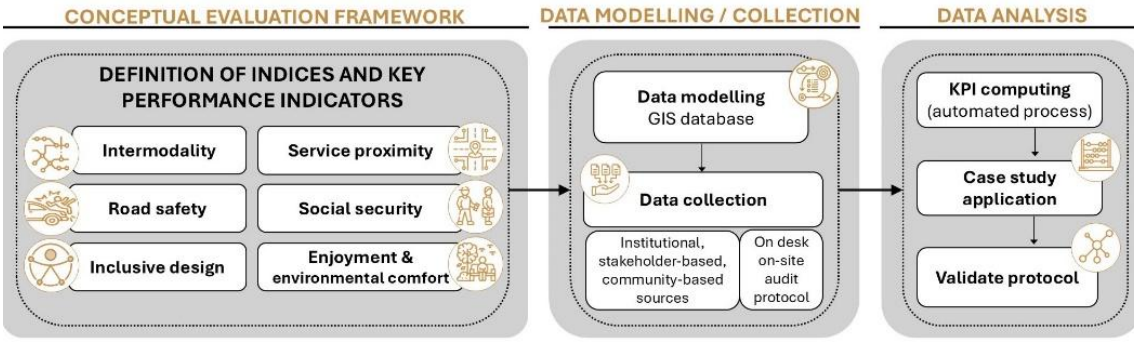

Figure 2: GIS-based and audit-based assessment framework.
Source: Authors' elaboration

Conceptual assessment framework. The definition of specilised performance indicators is the crucial part of the assessment framework, providing a structured methodology to identify strengths and vulnerabilities of urban spaces and mobility networks. A set six Key Performance Indicators (KPIs) have been identified to provide a comprehensive evaluation: (i) Intermodality measures proximity and diversity of transport nodes and active mobility services; (ii) Service proximity evaluates the accessibility to essential facilities and economic activities organised in 4 categories, i.e., retail, education, healthcare and entertainment; (iii) Safety assesses infrastructure quality, pedestrian/cyclist protection, and path detectability; (iv) Social security analyses perceived risks related to crime and degraded or unqualified streetscapes; (v) Inclusive Design measures infrastructure inclusivity for users with different abilities; (vi) Enjoyment & environmental comfort evaluates the attractiveness and environmental qualities of urban spaces. KPI (i) and (ii) rely on spatial analysis techniques, which quantify accessibility and connectivity patterns within the urban network. Instead, KPIs from (iii) to (vi) rely on an infrastructure-based approach which evaluates the physical and functional characteristics of pedestrian and cycle networks (Table 1).

Table 1: Infrastructure-based KPIs and indices evaluation criteria.

KPIs	*Indices and evaluation criteria*
Safety	Infrastructure - presence/absence of dedicated infrastructure
	Pedestrian/cyclist protection (from vehicular traffic)
	Path detectability - signage and markings
Social security	Perception - degraded sites, underpasses, lighting
	Eye-on-the-street - natural surveillance of active streetscape
Inclusive design	Practicability (for all users) - width, bottlenecks, slope
	Architectural barriers - tactile signage or natural guides, crossing devices
	Obstacles - pavement quality, trip hazard, and steps
Enjoyment & environmental comfort	Attractiveness - interesting and liveable streetscape
	Environmental comfort – shading, shelters, greenery
	Rest and repair points - seating, water point, bike repair stations

Authors' elaboration.

GIS data modelling and data collection. A second methodological step is the data modelling of the GIS database, fundamental for organising the necessary data and datasets to compute the previously defined indicators. While the indicators are aggregated into thematic KPIs, the GIS database ensures that the complexity of collected data is preserved, allowing for detailed analysis without losing important spatial and contextual information. Data collection integrates multiple data sources, including official datasets from institutional geoportals, stakeholder-provided datasets, community-based and crowd-sourced databases (e.g., OpenStreetMap), and on-desk and on-site audits supported by a GIS web tool and a collaborative data collection application (ArcGIS FieldMap).

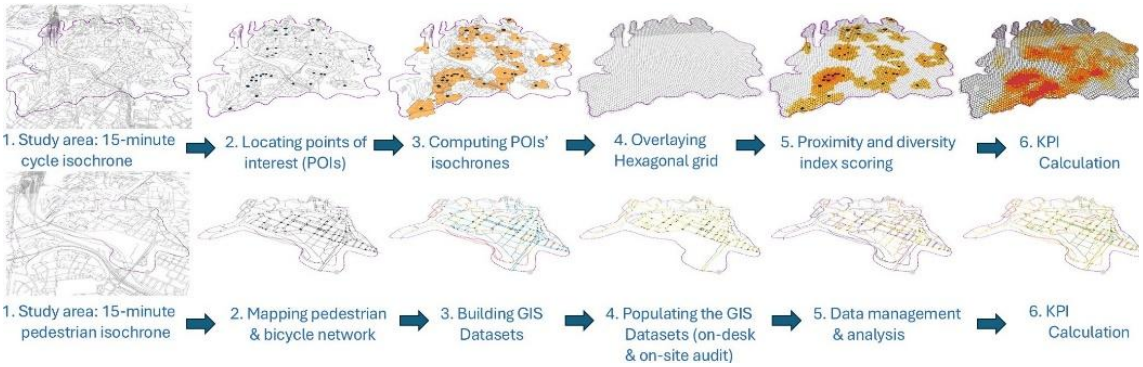

Figure 3: GIS methodological approaches: a) spatial-based (top); b) infrastructure-based (bottom).
Source: Authors' elaboration

Data analysis and output generation. The third methodological step develops data processing for the computing of KPIs. Concerning KPI (i) and (ii), isochrone analysis and service area delineation through ArcGIS Network Analyst, help determine how well urban areas are served by collective transport nodes and services (POIs). This analysis is based on a system of hexagonal grids to collect the proximity and diversity scores of the POIs supply and to ensure uniform spatial coverage (Fig. 3a). KPI from (iii) to (vi) follow

an infrastructure-based approach, which relies on the aggregation of selected attributes of pedestrian and cycling links (Fig.3b and Table 1).

The outputs generated by the application of data processing in a real case study are expected to validate the methodological approach and support specific micro-scale planning guidelines. This phase also allows the generation of a base-line evaluation layer of accessibility, walkability and bikeability, useful for next methodological approaches.

3.2 Machine learning-based modelling

The spatial data and audit-derived indicators were used to train machine learning models, to be employed for "massive" assessment of walkability and mobility-oriented urban quality. These models can be trained and validated using both the quantitative results of the GIS analysis and the behavioural data collected through stated preference surveys. This enables the extraction of patterns and prediction of walkability scores under different scenarios (e.g., for different user profiles with different socio-demographic characteristics).

The automated tool for large-scale walkability evaluation leverages the generalization capabilities of modern machine learning and deep learning techniques. Its primary function is to estimate perceived walkability across a defined geographic region, using street-level imagery as the main input data source.

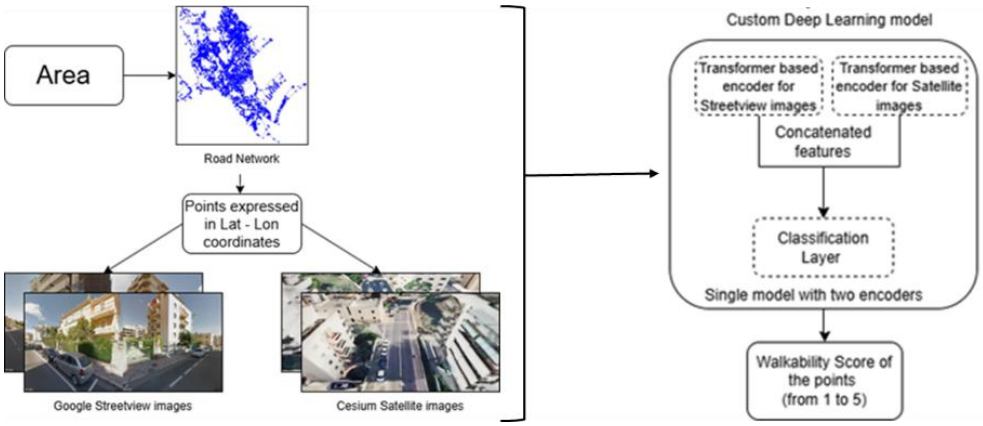

Figure 4: Pipeline for join assessment of both Street View and satellite imagery. The process begins with downloading the road network and sampling representative points for image extraction. Two alternative approaches are proposed to integrate the information from both image sources. A dotted line visually distinguishes the two solution paths within the workflow.

Source: Authors' élaboration, partially based on OSM, Google Streetview images and Cesium Satellite images.

Perceived walkability is quantified using a five-point ordinal scale, ranging from 1 (indicating poor walkability) to 5 (indicating excellent walkability). This composite score reflects multiple qualitative aspects, including pedestrian safety, comfort, the absence of physical barriers, and the overall quality and visual appeal of the surrounding environment. To automate this assessment, an advanced deep learning model was developed and trained, based on a custom architecture (Fig. 4) that combines two Swin Transformers, one finetuned on street-view imagery and another one in satellite imagery. For the Dual Swin Encoder model, over 17,000 street-level images—previously evaluated

by human annotators—served as the training, validation, and testing dataset. This model achieved a performance of 78% for exact class prediction and 98% for predictions that were either exact or off by only one class level.

3.3 Immersive Stated Preference Survey Design for Walkability Assessment

The approach regards on determining the extent to which contextual and infrastructural characteristics – specifically walkability levels – can influence the intention to walk, while simultaneously evaluating the attractiveness of different project scenarios. In this context, the selection of evaluation methodologies plays a fundamental role. Traditionally, survey-based methods, such as Revealed Preference (RP) and Stated Preference (SP) surveys, have been employed to gather information on travel behaviour. These surveys involve presenting participants with various real or hypothetical scenarios described through text, leaving the context entirely to the participant's imagination. Data collection methods such as questionnaires are inherently based on implicit responses, where participants react to spontaneous, automatic, or unconscious cues. Implicit measures are often considered a way to tap into a more authentic psychological construct, while also being less prone to issues associated with self-reporting methods, such as socially desirable responses (Harms & Luthans, 2012). The use of mixed research methods, which combine visual approaches with questionnaires, can significantly strengthen the validity of research results (Peroff et al. 2020). Visual methods, in fact, provide a robust means of examining disparities between implicit and explicit methodologies (Andrews & Leonard, 2018). In line with this, in recent years, researchers have acknowledged the limitations of relying solely on text-based scenarios and have explored alternative methods that provide a more realistic and immersive way to study the perceptual and behavioural aspects related to active mobility use. These advanced methods leverage images and short video clips, offering participants a more vivid and context-rich experience. For example, Clark et al. (2019) used this approach to assess willingness to try cycling in hypothetical situations. By showing participants realistic visual representations of these scenarios, researchers can gain a better understanding of how people perceive and respond to different cycling conditions. Kasraian et al. (2021) focused on quantifying pedestrians' perception of walkability through a stated preference survey using a dynamic 3D representation of various street designs in Toronto, Canada. Another crucial element, especially when investigating cycling behaviour, is perceived risk assessment. Parkin et al. (2007) used visual materials to study how individuals perceive the risks associated with cycling. By using images or videos simulating various road conditions and situations, researchers can more accurately capture participants' perceptions in terms of safety and risk, which can inform urban planning and safety initiatives. This shift toward visual and multimedia research tools can lead to more accurate and valuable insights for urban planners, policymakers, and researchers working to promote sustainable transport options and improve cycling experiences.

In light of the above considerations, the methodology relying on individuals' responses through the survey should serve two purposes: first, to evaluate the impact of each proposed scenario's characteristics and quantify, from the user's perspective, how walkability levels affect the intention to choose walking; and second, to identify the characteristics of users who are less likely to engage in active mobility, thereby helping to plan promotional actions targeting more reluctant individuals. In ordered to satisfy these condition, the methodology to gather individuals' propensity to walk include the

following steps: i) design of various active mobility scenarios ii) digital modelling of scenarios and the existing conditions corresponding to each scenario using Twin motion software; iii) construction of an immersive stated preference survey through which the intention to walk or cycle in each scenario can be evaluated relative to the current scenario, thereby identifying the potential demand; iv) analysis of the potential demand through discrete choice models.

4. Results

4.1 Application of GIS-based and audit-based analysis.

The implementation of the GIS database and assessment protocols in the urban area surrounding the Val D'Ala station – within a 15-minute isochrone – resulted in the generation of several thematic maps illustrating the indices and KPIs defined in the assessment framework.

Fig. 6 presents the results of the spatial-based analysis, which led to the representation of two KPIs: Intermodality and Service Proximity. The Intermodality map assigns each hexagonal cell an aggregated accessibility score, calculated as the average of the combined values for the frequency and diversity of transport nodes – i.e., metro stops, bus stops, taxi stands, car parks, bike parks and shared mobility services (e.g., car sharing stations). Similarly, the Service Proximity map provides, for each cell, an aggregated accessibility score based on the average of the combined values for the number and diversity of public facilities and economic activities, classified into 4 functional categories (retail, education, healthcare, entertainment).

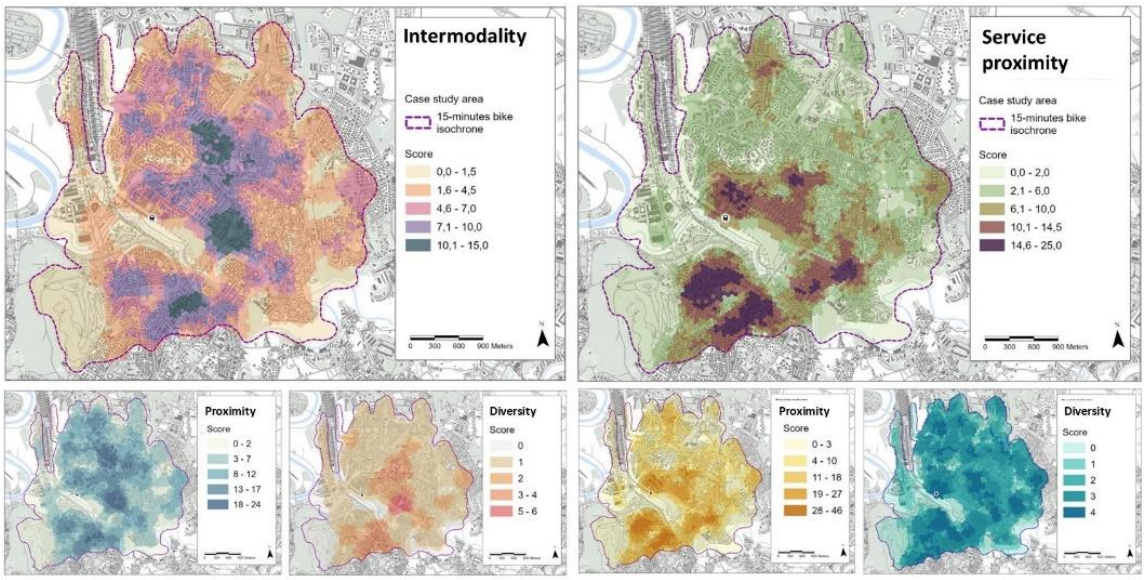

Figure 6: KPIs resulting from the application of the spatial-based methodology.
Source: Authors' élaboration, based on OSM and CERVED datasets.

Fig. 7 shows the results of the infrastructure-based analysis, which generated four additional KPIs: Safety, Social Security, Inclusive Design, and Enjoyment & Environmental Comfort. Each map represents, for every pedestrian network link, the normalised values of the mean scores assigned to each evaluation criterion (Table 1). An

empirical classification of the results allowed the identification of five performance classes, ranging from poor to excellent.

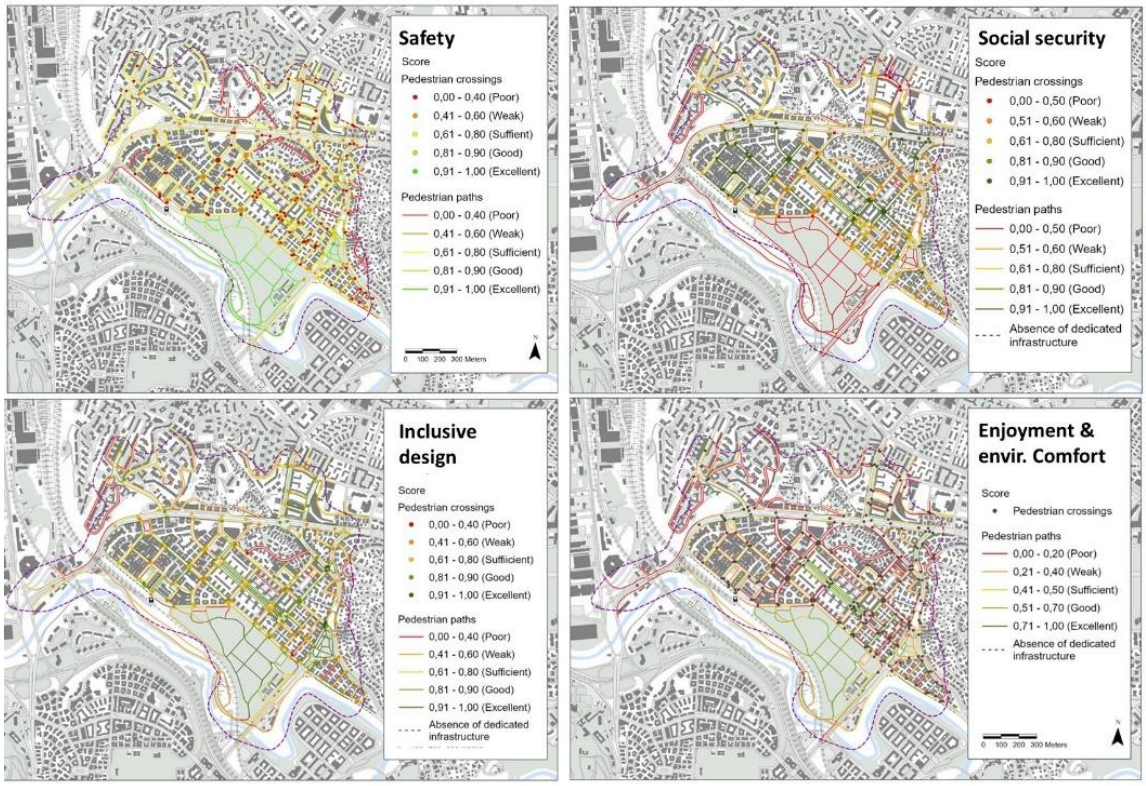

Figure 7: KPIs resulting from the application of the infrastructure-based methodology.
Source: Authors' élaboration, based on audit-based data.

The results were subsequently verified to ensure the consistency of the aggregate indicator calculations with the actual conditions of the urban site. This verification was carried out through the consultation of extensive photographic documentation.

4.2 Application of ML-based models.

The model was run to evaluate walkability using imagery sourced from Google Street View, sampled from relevant nodes in the road network defined by OpenStreetMap (Fig. 8).

However, because Google Street View imagery is captured from vehicle-mounted cameras, it does not always reflect the visual experience of pedestrians. To compensate for this limitation, we supplement the street-level images with satellite views – specifically, bird's-eye perspectives obtained using the Cesium ION plugin integrated into the Unreal Engine. For each of the original points, the camera was placed to snap one picture in the front and one in the back (see example in Fig. 9).

This addition provides essential contextual information often used by humans to evaluate walkability – such as the continuity of sidewalks, urban density, and neighborhood accessibility – that may not be visible from ground-level imagery alone. Incorporating satellite images at each evaluation point enriches the model's spatial awareness, enhancing its ability to emulate human-like assessments of walkability beyond what is visible in a single frame.

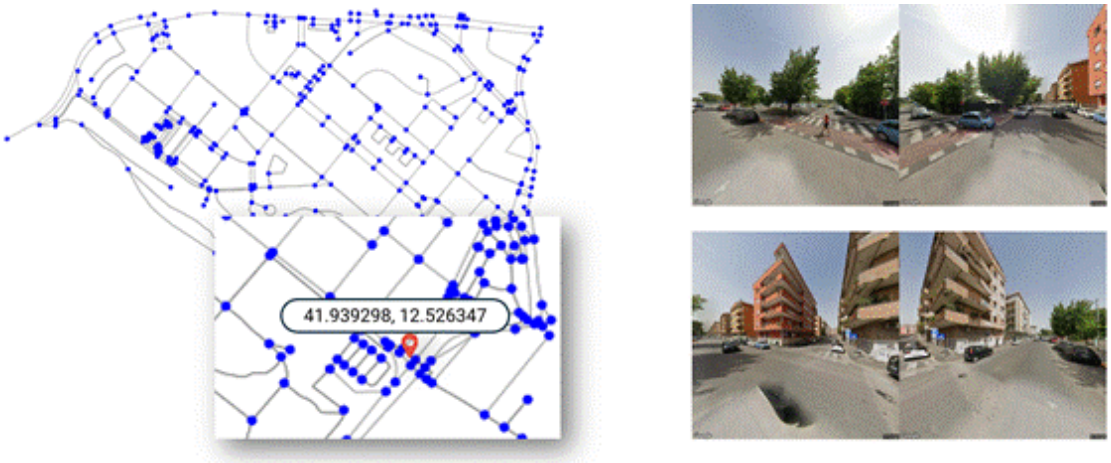

Figure 8: Example of a street view imagery submitted to models for assessment.
Source: Authors' élaboration, based on OSM dataset and Google StreetView imges.

Figure 9: Example of bird's-eye perspectives obtained using the Cesium ION plugin integrated into the Unreal Engine.
Source: Cesium Satellite images.

Fig. 10 represents output of the automatic classifiers using the Dual Swin Encoder approach for the Val D'Ala neighbourhood, for each street segment, expressed as a score of perceived walkability on a scale from 1 to 5.

4.3 Application of Immersive Stated Preference Survey Design

Concerning immersive Stated Preference Survey Design applied in the Val D'Ala area, three different scenarios were designed: i) zone 30, ii) urban street with a segregated bicycle lane and iii) pedestrian and bicycle zone. This case study represents a model of urban regeneration aimed at promoting sustainable mobility, focusing on improving the appearance, functionality, and overall quality of life in the urban area by rehabilitating and repurposing underutilized or degraded spaces.

The design approach shifts from car-centred planning to a people-focused model that prioritises safety, accessibility, environmental quality, and quality of life. Core principles include universal accessibility, safety, efficient space use, and integration of essential functions. The CAD-modeled scenarios were later imported and processed using

Twinmotion software. A library of images was then created to illustrate the main routes to and from Val D'Ala station, showcasing both the current conditions and the proposed project scenario. A survey was then conducted using the SurveyEngine software, consisting of two main sections:

- Revealed Preferences: In this section, alongside collecting the user's sociodemographic characteristics, additional information was gathered to serve as a filter for directing participants to the next section.
- Stated Preference: here, the most realistic hypothetical scenario was presented, tailored to each user category – primarily based on the distance from the participant's home to Val D'Ala station. Four user categories were identified.

Figure 10: Assessments of street segments in the Val D'Ala neighbourhood.
Source: Authors' elaboration.

The experimental design adopted was an orthogonal design (Louviere et al., 2000), aimed at minimizing the correlation between attribute levels in the choice sets. The scenario included the three intervention types described earlier (30 km/h zone, cycle path, and shared pedestrian/cyclist area), each presented randomly three times. The scenarios were characterized using the following attributes: distance to be walked; typical pedestrian traffic; presence of trees/vegetation; pedestrian crossings; roadside parking; sidewalks. Each attribute had two, or at most three, levels of variation.

The final design, considering the number of attributes and their respective levels, resulted in a total of 24 hypothetical situations, divided into 8 blocks of 3 scenarios each. Participants were randomly assigned to one of these blocks, thus evaluating a total of 9 hypothetical situations (3 for each type of project, also presented in random order). In each situation, participants were asked to choose between: (1) walking along the current route (always the shortest), or (2) choosing a longer route where an intervention aimed at improving walkability had been implemented. An opt-out (non-choice) option was provided in all hypothetical situations.

Figure 11: One of the nine hypothetical scenarios presented to the users.
Source: Authors' élaboration, using Twinmotion.

5. Discussion and conclusion

The application of the integrated methodological framework to the case study enabled the calibration of the proposed techniques and resulted in the development of a validated and transferable suite of tools, ready for deployment. The main outcomes include: (1) an architecture of shared data integrated in GIS tools; (2) a suite of audit protocols including auditors' training materials and GIS app-based tools, helpful for computing walkability and bikeability indices; (3) ML-based predictive modules and software tools for large-scale assessments; (4) protocols for choice modelling experiments.

The methodological approach is structured as a multi-level and modular workflow, integrating various analytical dimensions and methods. This structure allows for scalable implementation and tool interoperability, adaptable to different urban contexts, depending on data availability. The implemented GIS database supports the definition of multi-thematic performance indicators aimed at identifying both strengths and vulnerabilities in urban space and pedestrian/cyclist networks. These indicators could serve to improve the spatial organization of social and transport services and the overall quality of public space. Furthermore, the GIS layer provides a baseline for walkability and accessibility assessment, which is useful for training and calibrating ML-based predictive components. The empirical behavioural analysis conducted through surveys and immersive choice experiments supports the identification of user profiles, sensitivity to urban features, and the customisation of evaluation indicators. These behavioural insights could serve two main purposes: (1) training and validating ML algorithms to reflect real-world preferences and perceptions; (2) enabling the future customisation of planning scenarios according to different target groups (e.g. children, elderly, cyclists). The application of machine learning modelling further demonstrated its strong potential for easy replication in other urban contexts. The models can be trained and validated using both the quantitative outputs of the GIS analysis and behavioural data from stated preference surveys, enabling the identification of patterns and the prediction of walkability scores under different scenarios.

Despite the robustness and scalability of the proposed framework, some limitations remain that should be acknowledged. First, the availability of input data: e.g., the coverage of Google Street View imagery may not be uniform across all geographical contexts, and OSM data may present inconsistencies or gaps in attribute detail. Similarly, the resolution and representativeness of behavioural data collected through stated preference surveys may be constrained by sample size and context-specificity. Another limitation concerns the high cost of audit-based methods, which can hinder large-scale

replicability. In future developments, data collection could be partially automated using AI-based recognition systems applied to high-resolution satellite or aerial imagery.

Anyway, the integrated approach ensures a rigorous and adaptable support tool for mobility-sensitive regeneration of railway station areas, monitoring and evaluation of active mobility interventions, and development of specific planning guidelines. Positive impacts are also expected for the partner company, as the evaluation model offers standardisation and replicability in analysis and data collection, as well as increased efficiency, transparency, and overall quality in the evaluation process through automation.

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Acknowledgements

This work was supported within the framework of the "Sustainable Mobility Centre" (CNMS) Spoke 5 and Spoke 9. Funder: Project funded under the National Recovery and Resilience Plan (NRRP), Mission 4 Component 2 Investment 1.4 - Call for tender No. 3138 of 16/12/2021 of Italian Ministry of University and Research funded by the European Union – NextGenerationEU. Award Number: Project code CN00000023, Concession Decree No. 1033 of 17/06/2022 adopted by the Italian Ministry of University and Research, CUP D93C22000400001, "Sustainable Mobility Center" (CNMS).

This manuscript reflects only the authors' views and opinions, neither the European Union nor the European Commission can be considered responsible for them.

The authors jointly designed and contributed to the paper. Conceptualisation, integrated methodology, data curation and analysis, all authors; writing—original draft preparation,

review and editing, B.C., L.J.M. and G.T. (§ 1, 2.2, 3.1, 4.1, 5); A.E., S.M. and C.R. (§ 2.1, 4 introduction); I.B. and M.M. (§ 3.2, 4.2); I.M., F.P. and E.S. (§ 3.3, 4.3).