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INFRASTRUTTURE DI PROSSIMITÀ Metodi e strategie per la rigenerazione dei comparti ferroviari della rete lombarda

INFRASTRUCTURES FOR PROXIMITY Methods and strategies for the regeneration of railway station areas in the Lombardy network

Maria Pilar Vettori, Silvia Battaglia, Francesca Daprà, Andrea Dechamps

ABSTRACT

La rigenerazione delle stazioni ferroviarie rappresenta un ambito strategico per l'integrazione tra le infrastrutture di mobilità, lo spazio pubblico e la coesione territoriale. Il contributo propone un metodo sistemico per l'analisi e l'orientamento programmatico degli interventi sui comparti ferroviari, intesi come infrastrutture territoriali di prossimità, capaci di promuovere l'equità territoriale e l'inclusione sociale. A partire dal confronto tra modelli nazionali e internazionali e dall'analisi del sistema ferroviario lombardo la ricerca definisce uno strumento multicriteriale finalizzato all'analisi e alla valutazione delle stazioni e alla costruzione di indirizzi operativi per la loro rigenerazione. L'applicazione al caso di Milano Cadorna (Italia) restituisce un profilo per macroaree, evidenziando criticità, potenzialità e priorità di intervento e configurando un metodo replicabile su scala di rete. Il paper si propone come chiave di lettura di un Patrimonio infrastrutturale oggi bisognoso di una rigenerazione sistemica replicabile in contesti ferroviari regionali analoghi.

The regeneration of railway stations represents a strategic field for integrating mobility infrastructures, public space, and territorial cohesion. This contribution proposes a systemic method for the analysis and programmatic orientation of interventions on railway station areas, understood as territorial infrastructures of proximity, capable of promoting territorial equity and social inclusion. Starting from a comparison between national and international models and from the analysis of the Lombardy railway system, the research defines a multi-criteria tool for the analysis and evaluation of stations and the development of operational guidelines for their regeneration. The application to the Milano Cadorna case (Italy) provides a profile structured by macro-areas, highlighting critical issues, opportunities, and intervention priorities, and outlining a method that can be replicated at the network scale. The paper presents an interpretative framework for an infrastructural heritage that now requires systemic regeneration, together with a method that can be replicated in comparable regional railway contexts.

KEYWORDS

stazioni ferroviarie, rigenerazione dei comparti di stazione, infrastrutture di prossimità, intermodalità, valutazione multicriteriale

railway stations, station area regeneration, proximity infrastructures, intermodality, multi-criteria evaluation

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Fin dalla loro diffusione ottocentesca le reti ferroviarie e i relativi nodi infrastrutturali hanno costituito dispositivi che hanno caratterizzato l'impianto urbano europeo, organizzando relazioni spaziali, economiche e sociali su scala territoriale. Nella contemporaneità tali nodi non sono più esclusivamente luoghi di transito, bensì ambiti multiscalarmente chiamati a ridefinire il proprio ruolo tra efficientamento tecnico, qualità dello spazio pubblico e nuove istanze di inclusione e sostenibilità, in una rinnovata relazione tra infrastruttura e città. Le stazioni ferroviarie hanno progressivamente ampliato le loro funzioni e i loro significati urbani, evolvendosi da nodi logistici monumentali e catalizzatori della crescita industriale ottocentesca (Meeks, 1995; Bertolini and Spit, 1998) a poli multifunzionali e attori della riqualificazione territoriale a partire dagli anni '80 e '90 dello scorso secolo (Cervero, 1998; Bertolini, 1996; 1999; Peters and Novy, 2012).

La revisione della letteratura è stata condotta attraverso l'analisi di contributi scientifici recenti e di documenti istituzionali nazionali e internazionali sul tema della rigenerazione delle stazioni e dei sistemi di mobilità, selezionati in relazione alle dimensioni di accessibilità, intermodalità, prossimità, sostenibilità e governance. L'obiettivo della revisione è stato individuare modelli interpretativi e operativi utili alla costruzione del quadro teorico di riferimento e alla definizione delle dimensioni analitiche alla base del metodo proposto.

La recente trasformazione delle stazioni ha comportato l'integrazione di funzioni di servizio e di prossimità, nonché l'adozione di standard per l'inclusione sociale (Ricci, Poli and Marino, 2025; Cangelini, 2025), in continuità con approcci di pianificazione quali il Transit-Oriented Development (TOD), che promuovono densificazione mista e accessibilità sostenibile (Cervero, 1998; Bertolini, 1999; Banerjee and Saha, 2022) e la stazione quale nodo di inclusione (Canessa and Centanaro, 2024). Il paradigma della 'città dei 15 minuti' ha consolidato ulteriormente la potenzialità delle stazioni quali nodi locali per servizi essenziali, con ricadute sulla qualità della vita, sulla densificazione compatibile e sulla distribuzione dei servizi sul territorio (Ricci, Poli and Marino, 2025; Fiorini et alii, 2025; Otsuka and Reeve, 2024).

Nel contesto italiano la trasformazione dei comparti ferroviari si sviluppa lungo due direttrici principali: la riqualificazione delle grandi stazioni come dispositivi urbani complessi e la riconversione diffusa del Patrimonio tramite pratiche di riuso sociale e micro-hub di prossimità (RFI, 2015, 2022). La letteratura italiana ha privilegiato la valutazione del potenziale rigenerativo delle stazioni in relazione alle politiche urbane e alle trasformazioni simboliche e funzionali dello spazio-stazione (Conticelli, 2011; Paone, 2023), mentre la diffusione di pratiche partecipative ha rafforzato il ruolo degli attori locali nella definizione di spazi pubblici e servizi di welfare connessi alle stazioni (Campagnaro et alii, 2025).

Negli ultimi due decenni la digitalizzazione e l'attenzione alla sostenibilità hanno accelerato tale metamorfosi: la 'smartification' (sensori, bigliettazione elettronica e sistemi informativi) e le soluzioni integrate di mobilità (bike-sharing, parcheggi di interscambio e mobilità condivisa) hanno migliorato l'efficienza operativa e l'esperienza degli utenti, coerentemente con le politiche di riduzione delle emissioni e di rigenerazione degli spazi pubblici (UIC, 2017; Griffin and Sener, 2016; ITF, 2015; European

Commission, 2011). In questa prospettiva alcuni studi hanno evidenziato come il futuro delle stazioni sia caratterizzato da una progressiva dissoluzione dei confini tra edificio e città, tra spazio pubblico e infrastruttura, configurando i nodi multimodali come ambienti porosi, che pongono l'uomo al centro e sono capaci di integrare funzioni urbane, servizi e sistemi digitali (ARUP, 2019, 2020). La stazione è stata progressivamente considerata un attore rilevante nella 'mobilità attiva' dei cittadini, contribuendo allo sviluppo di quartieri e contesti egualitari (ARUP, 2022): esperienze recenti mettono in luce il ruolo di piccoli hub e dispositivi multifunzionali di micromobilità come infrastrutture di connessione tra il nodo ferroviario, lo spazio pubblico e i servizi urbani (Fabbri, 2023).

Le evidenze empiriche e analitiche indicano come gli assetti infrastrutturali e le politiche di rigenerazione possano contribuire a una giustizia spaziale e a uno sviluppo sostenibile (Fiorini et alii, 2025; Cangelini, 2025), mentre pratiche partecipative e presidi civici consolidano la funzione sociale e identitaria delle stazioni (Bertolini, le Clercq and Kapoen, 2005; Campagnaro et alii, 2025; Setola and Borghiani, 2025). Persistono tuttavia sfide rilevanti: gestione e percezione della sicurezza, conciliazione tra tutela del Patrimonio e modernizzazione funzionale, complessità di una governance multilivello per interventi integrati (Berretta, Desideri and Staltari, 2024; Campagnaro et alii, 2025) e obsolescenza degli apparati tecnologici. In prospettiva le stazioni sono chiamate a svolgere ruoli ibridi, quali nodi multimodali e piattaforme per la transizione ecologica e sociale delle città, il che richiede approcci interdisciplinari per la loro comprensione e governance (Bertolini, 1999; Cervero, 1998).

A differenza delle prospettive che leggono la stazione prevalentemente come nodo (TOD, modello nodo-luogo) o come presidio civico (riusi sociali), il contributo concepisce la stazione come infrastruttura territoriale di prossimità, ovvero come dispositivo spaziale e sociale diffuso da leggere su scala di rete. L'originalità del paper risiede nella proposta di uno strumento multicriteriale e multiscalare che integra dimensioni infrastrutturali, spaziali e sociali in uno strumento comparativo orientato alla programmazione, colmando il divario tra approcci centrati sulla sola prestazione infrastrutturale e pratiche incentrate su riusi sociali puntuali e locali: lo studio si colloca così nel più ampio dibattito sulle infrastrutture di mobilità intelligenti e sostenibili come nuovo sistema di connessioni urbane, che richiede di integrare performance tecnica, qualità spaziale e obiettivi ambientali (Bruno et alii, 2024).

Alla luce del quadro delineato il contributo presenta gli esiti di una ricerca finalizzata a interpretare le stazioni ferroviarie come infrastrutture territoriali di prossimità su scala di rete, attraverso la messa a punto di uno strumento applicato al sistema delle stazioni lombarde e verificato nel caso di Milano Cadoma (Italia). La ricerca persegue tre obiettivi principali: 1) costruire un quadro conoscitivo comparabile delle stazioni sulla base di dimensioni infrastrutturali, spaziali e sociali; 2) definire uno strumento multicriteriale e multiscalare capace di orientare le scelte di rigenerazione; 3) verificarne l'efficacia, mediante un caso di studio complesso, nel supportare processi decisionali condivisi.

Il percorso metodologico si articola in tre fasi integrate: mappatura conoscitiva della rete lombarda; valutazione multicriteriale delle stazioni; appli-

cazione al caso di Milano Cadoma. Coerentemente con tale impianto il testo si sviluppa in un percorso che, dopo il confronto tra alcune esperienze europee e italiane di rigenerazione delle stazioni, inquadra il sistema lombardo quale campo di applicazione della ricerca, espone il metodo elaborato, ne verifica l'operatività attraverso il caso studio di Milano Cadoma e infine discute gli esiti emersi in termini di criticità, potenzialità e trasferibilità.

In questa prospettiva il contributo intende offrire alla comunità scientifica un quadro concettuale e operativo per interpretare le stazioni come componenti di un'infrastruttura territoriale diffusa e per orientarne la rigenerazione mediante uno strumento comparativo e replicabile. L'apporto dello studio risiede, in particolare, nella possibilità di connettere la lettura sistemica, la valutazione multicriteriale e la definizione di indirizzi operativi, così da sostenere politiche e progetti in una prospettiva di equità territoriale, integrazione infrastrutturale e qualità dello spazio pubblico.

Esperienze a confronto per la rigenerazione delle stazioni

I casi di riferimento internazionali e nazionali sono stati selezionati in quanto espressione di due traiettorie oggi rilevanti nella rigenerazione ferroviaria europea e italiana: da un lato modelli orientati all'integrazione tra infrastruttura, sviluppo urbano e qualità dello spazio pubblico, dall'altro modelli centrati sul riuso sociale e sulla riattivazione capillare del Patrimonio esistente. In particolare il caso delle ferrovie olandesi è stato selezionato in virtù del fatto che i Paesi Bassi costituiscono uno dei laboratori più strutturati di integrazione tra trasporto e sviluppo urbano, come dimostra l'estesa bibliografia scientifica che se ne occupa attraverso una copiosa documentazione disponibile. La comparazione è stata condotta secondo criteri omogenei al fine di individuare le dimensioni metodologiche più utili alla costruzione del framework proposto.

Il fondamento teorico di tale approccio risiede nel modello 'nodo-luogo' elaborato da Bertolini (1996; 1999), che interpreta la stazione come dispositivo in cui si intrecciano l'accessibilità infrastrutturale (valore del nodo) e l'intensità funzionale urbana (valore del luogo). Il modello, sviluppato e applicato nel contesto olandese da Peek, Bertolini e De Jonge (2006), ha orientato le politiche di pianificazione integrate e le valutazioni del potenziale di sviluppo delle aree di stazione. La letteratura mostra che tale processo non è episodico né recente: alcuni studi documentano una fase di maturazione, caratterizzata dall'integrazione tra la riqualificazione infrastrutturale, lo sviluppo immobiliare e le nuove funzioni urbane (Bruinsma, 2009). In una prospettiva comparativa Peters e Novy (2012) collocano tali interventi all'interno dei megaprogetti di rigenerazione delle aree delle stazioni ferroviarie, evidenziando il potenziale conflitto tra sostenibilità dei sistemi di trasporto e competitività urbana.

Il modello olandese si fonda su una governance strutturata tra Nederlandse Spoorwegen (NS), responsabile della gestione del Patrimonio, e ProRail, gestore dell'infrastruttura, con il supporto di strumenti di policy quali Spoorbeeld e Het Stationsconcept¹ (Bureau Spoorbouwmeester, 2025). Gli Annual Report di NS (Nederlandse Spoorwegen, 2024) e il Transport Plan 2025 (Nederlandse Spoorwegen, 2025) attestano una strategia di rete orientata all'intermodalità, alla qualità spaziale e alla sostenibilità, applicata a oltre 400 stazioni. In tali do-

cumenti il ruolo delle stazioni è riletto come catalizzatore di spazio pubblico di prossimità, capace di favorire interazioni tra mobilità pubblica, ciclabilità, servizi e funzioni urbane nei pressi dei nodi ferroviari. Da tale quadro emergono dimensioni operative ricorrenti: accessibilità multimodale, integrazione con lo spazio pubblico urbano, attrattività territoriale, qualità ambientale e spaziale, circolarità e sostenibilità, mixité di funzioni e governance multilivello.

Nel contesto italiano la traiettoria si sviluppa con modalità diverse; a seguito della centralizzazione dei sistemi di controllo e della riduzione del presidio fisico delle stazioni Rete Ferroviaria Italiana (RFI, 2015) ha avviato una politica di riuso degli immobili, tramite il programma Stazioni Impresenziate, che attiva processi di riconversione mediante comodato gratuito a Enti locali e Organizzazioni del terzo settore: la stazione assume così una funzione di presidio territoriale e infrastruttura civica, ospitando servizi culturali, sociali e di prossimità. Il rapporto di Zandonai (2015) interpreta tali esperienze come l'attivazione di 'asset comunitari', articolando il ciclo di riuso in fasi che includono la governance, la sostenibilità economica e la valutazione degli impatti. In tale prospettiva la rigenerazione non è riducibile a una mera riqualificazione fisica, ma configura un processo di innovazione sociale che coinvolge attori pubblici, Enti proprietari e Organizzazioni della società civile e che rafforza il ruolo della stazione come presidio territoriale.

Il confronto tra le esperienze europea e italiana evidenzia due traiettorie complementari: da un lato un modello orientato alla trasformazione urbana e alla performance infrastrutturale, sostenuto da una consolidata tradizione teorica e istituzionale, dall'altro un modello diffuso e sociale, centrato sulla riattivazione del Patrimonio e sull'innovazione comunitaria (Tab. 1). In particolare il modello italiano

privilegia la rifunzionalizzazione degli spazi, mentre risulta meno strutturato il rafforzamento degli elementi infrastrutturali, dell'intermodalità e della sostenibilità ambientale in un'ottica di equità territoriale su scala di rete.

Alla luce di tali evidenze e della letteratura recente sulla 'rigenerazione delle aree delle stazioni' emerge la necessità di un approccio capace di integrare la dimensione infrastrutturale, la qualità spaziale, la prossimità funzionale e la governance di rete. Sebbene tali dimensioni siano ampiamente riconosciute, nei casi analizzati risultano trattate in modo settoriale, privilegiando alternativamente la performance urbana o la riattivazione sociale del Patrimonio. In questo quadro il confronto tra i due modelli analizzati assume un ruolo fondativo nella costruzione del metodo proposto: le loro potenzialità e criticità sono state tradotte in dimensioni operative e successivamente integrate nel panel degli indicatori, definito sulla base della documentazione analizzata. Il contributo propone pertanto una lettura delle stazioni come infrastruttura territoriale diffusa, traducendo i riferimenti teorici su prossimità, intermodalità e governance in uno strumento multicriteriale applicabile al contesto italiano.

Il sistema delle stazioni lombarde come infrastruttura territoriale | Negli ultimi anni Regione Lombardia ha avviato iniziative volte a valorizzare il sistema delle stazioni ferroviarie lombarde, con l'obiettivo di rafforzare il ruolo come presidi riconoscibili e funzionalmente integrati nelle politiche di mobilità sostenibile e di rigenerazione urbana.

La mole degli impianti ferroviari presenti sul territorio regionale è infatti cospicua: la rete si estende per circa 2.000 km e comprende 464 stazioni, di cui 125 (alcune inattive) sono a gestione regionale diretta e affidate in concessione a Ferrovie Nord (FN) mentre la restante parte è gestita da Rete Ferro-

viaria Italiana (RFI) e Ferrovie Emilia-Romagna (FER). Nel 2023 la Regione Lombardia ha promosso uno studio per lo 'sviluppo e valorizzazione del sistema delle stazioni ferroviarie e la progettazione di strumenti operativi' (SINLOC, 2023), finalizzato a individuare modelli operativi e strumenti replicabili per la rifunzionalizzazione del Patrimonio, con particolare attenzione alle Stazioni Impresenziate, in numero crescente². Lo studio riconosce alle stazioni una nuova vocazione di interesse pubblico, da attuarsi attraverso il coinvolgimento delle Amministrazioni comunali e l'attivazione di nuovi servizi e funzioni di prossimità, soprattutto nei territori meno serviti. L'approccio privilegia modalità di riuso adattivo, leggere e reversibili, orientate alla conservazione del Patrimonio esistente e alla sostenibilità ambientale e sociale.

In tale ambito la rete in gestione a FN³ rappresenta una parte rilevante dell'intera rete lombarda, risalente alla fine dell'Ottocento e diramata tra il cosiddetto Ramo Milano e il Ramo Iseo. Il Piano Strategico Ferrovie Nord Milano 2024-2029 (FNM, 2024a) riconosce alla rete ferroviaria il ruolo di asset infrastrutturale centrale, prevedendo investimenti di potenziamento e modernizzazione volti a migliorare la sicurezza, l'efficienza, la qualità del servizio e la sostenibilità ambientale, anche in un'ottica di mobilità sostenibile. In tale quadro la rete è intesa come struttura portante di un sistema regionale di mobilità integrata, la cui sostenibilità è stata recentemente dichiarata nel Bilancio di Sostenibilità (Trenord, 2024), che mira a migliorare la qualità ambientale e la circolarità nelle stazioni e nel servizio ferroviario.

Tra gli interventi prioritari si colloca il progetto FILI, programma integrato di trasformazione lungo l'asse Milano-Malpensa che interessa i principali nodi della rete (Milano Cadorna, Bovisa, Saronno e Busto Arsizio) e le loro aree limitrofe. Il progetto

Comparison criterion	NS Station Area Development (NL)	RFI Stazioni Impresenziate (IT)	Implications for the method
FRAMEWORK	Netherlands, entire railway system	Italian railway station heritage	Need for an approach adaptable to heterogeneous urban and territorial contexts
GOALS	Improvement of the urban and spatial quality of buildings and contexts	Reactivation of heritage and strengthening of territorial control	Integration of urban quality and the station's civic function
SCALE OF INTERVENTION	High-intensity urban interventions, similar to mega-projects	Widespread, capillary interventions across a national network of small and medium-sized stations	Introduction of a multi-scalar reading
GOVERNANCE	Structured multi-level framework (NS-ProRail-municipality); shared policy framework	Mainly local governance, based on agreements and protocols; involvement of the third sector	Integration of multi-level governance and participatory processes
MAIN REGENERATION DIMENSIONS	Multimodality, spatial quality, and environmental sustainability	Functionality and services, spatial quality, local proximity	Definition of the macro-areas of the multi-criteria checklist
INSTRUMENTS	Policy framework, guidelines, and urban transformation programmes	Reuse programmes, local agreements, and free-use agreements	Definition of a comparison tool based on selected benchmarks
STRENGTHS	Integration between infrastructure and city, high spatial quality, strong modal integration, standardisation of interventions, and formalised environmental criteria	Social activation, widespread reuse of heritage, territorial embeddedness, development of local services, and collaboration between institutions	Integration between infrastructural performance, spatial quality, and proximity services
CRITICAL ISSUES	High management and economic complexity, stronger concentration on the main nodes	Limited integration of environmental and intermodal dimensions, with site-specific interventions that are not always systemic	Need to overcome partial approaches by integrating the different dimensions that have emerged
TRANSFERABILITY	High in contexts characterised by structured governance and investment capacity	High in contexts with widespread heritage and active local networks	Definition of a modular and adaptable method

Tab. 1 | Comparison table of case studies between the Netherlands and Italy (credit: the Authors, 2026).



Fig. 1 | Classification of stations by typology (credit: the Authors, 2026).

opera a scala di corridoio infrastrutturale, articolando le azioni in tre livelli: rigenerazione dei nodi ferroviari, della superstrada ciclabile Milano-Malpensa (54 km) e interventi ambientali di riforestazione lungo l'asse. FILL assume la rete ferroviaria quale spina dorsale territoriale, integrando mobilità su ferro, mobilità dolce e continuità ecologica, rafforzando la lettura della ferrovia come infrastruttura urbana e territoriale integrata (FNM, 2024b).

Nel loro insieme le iniziative promosse da Regione Lombardia e dalle società del gruppo Ferrovie Nord Milano delineano una strategia di sviluppo che riconosce alla rete ferroviaria e alle sue stazioni un ruolo strutturante per l'accessibilità regionale, la transizione ecologica e l'equità territoriale. L'interesse istituzionale per interventi coordinati, multiscalari e replicabili conferma la centralità delle stazioni come dispositivi territoriali strategici, aprendo lo spazio a strumenti metodologici in grado di supportare in modo sistematico tali processi di trasformazione.

Un metodo sistemico per la rigenerazione delle stazioni come infrastrutture di prossimità | In tale ottica la ricerca propone un metodo operativo per orientare la trasformazione dei comparti ferroviari gestiti da Ferrovie Nord e delle aree limitrofe come perni di una rinnovata infrastruttura capillare di prossimità e di equità territoriale. La stazione è dunque assunta non solo come manufatto tecnico, ma come componente di un'infrastruttura territoriale di mobilità intelligente e sostenibile, in continuità con gli approcci che leggono le connessioni urbane come dispositivi integrati di trasporto, spazio pubblico e sostenibilità (Bruno et alii, 2024). Il metodo si articola in tre fasi integrate: analitico-conoscitiva, strategico-programmatica e applicativo-orientativa.

La prima fase analitico-conoscitiva consiste nella mappatura sistematica del Patrimonio ferroviario delle linee lombarde in gestione a Ferrovie Nord. L'analisi mira ad acquisire i dati relativi alle tipologie architettoniche e infrastrutturali delle stazioni⁴, ai flussi dei passeggeri, al ranking funzionale in uso dal gestore⁵ e allo stato dei manufatti (riqualificati

o da riqualificare) da restituire, mediante una mappatura, per fornire un quadro conoscitivo strutturato su scala di rete. Parallelamente viene effettuata la catalogazione degli spazi sottoutilizzati o residui nei fabbricati viaggiatori e nelle strutture limitrofe, al fine di individuare potenziali ambiti di attivazione. L'esito della fase consiste nella costruzione di una base territoriale e tipologica, funzionale a una lettura comparativa e multiscale delle stazioni (Figg. 1-3). La seconda fase strategico-programmatica elabora uno strumento multicriteriale di analisi e valutazione, che costituisce il nucleo operativo del metodo; tale impianto metodologico si colloca nell'alveo degli approcci di previsione strategica urbana che operano su più scale, orientando scenari e priorità di intervento più che singoli progetti puntuali (Mantziaras, 2024).

Lo strumento multiscale integra dimensioni urbane, infrastrutturali, architettoniche, gestionali e sociali e si compone di quattro elementi, valutabili in modo integrato:

1) Prevalutazione con posizionamento, elemento che acquisisce le classificazioni già condotte nella fase di mappatura, integrandole con l'inquadramento territoriale (urbano, periurbano ed extraurbano); la prevalutazione calibra l'applicazione della checklist in relazione al profilo della stazione e definisce il livello di approfondimento necessario; 2) Checklist multi-criteriale, elemento articolato in cinque macro-aree (accessibilità e intermodalità; funzionalità e prossimità; sostenibilità ambientale e sociale; qualità spaziale; sicurezza e presidio) e in criteri per ciascuna area, costituisce lo strumento principale di valutazione qualitativa; le aree, i criteri e gli indicatori derivano da una revisione sistematica della letteratura scientifica sui processi di rigenerazione delle stazioni, nonché dall'analisi di documenti e framework operativi istituzionali, internazionali e nazionali⁶; gli indicatori sono stati validati attraverso il confronto con gestori del Patrimonio e stakeholder territoriali; la checklist può essere applicata uniformemente a tutte le stazioni della rete e la percentuale di soddisfazione degli indicatori prevede una valutazione qualitativa espressa in livello alto, medio o basso⁷;

3) Analisi tecnico-specialistiche mirate, attivate selettivamente a supporto della checklist, che includono rilievi dello stato di fatto, analisi dei vincoli, analisi delle caratteristiche storiche e architettoniche della stazione; analisi dei flussi, analisi delle caratteristiche gestionali della stazione e ulteriori analisi tecnico-specialistiche ove necessarie;

4) Strumenti di partecipazione multilivello, integrati nella fase valutativa e articolati in due livelli; il primo livello utilizza gli strumenti propri della partecipazione nell'ambito della governance tramite interviste, focus group e tavoli di lavoro con stakeholder, locali e sovralocali, con l'obiettivo di favorire il dialogo e lo sviluppo di policy condivise; il secondo livello coinvolge direttamente gli utenti della stazione e la popolazione tramite un questionario e l'avvio di tavoli di lavoro di co-progettazione; gli esiti partecipativi alimentano la definizione del quadro esigenziale e la selezione delle priorità.

L'esito della seconda fase è un profilo articolato per macroaree con una valutazione qualitativa che evidenzia criticità, ambiti consolidati e potenzialità di attivazione. La terza fase applicativo-orientativa consiste nell'applicare lo strumento ai comparti individuati. I risultati della fase strategico-programmatica vengono ricomposti in un profilo sintetico della stazione, che consente di graduare le priorità di intervento in relazione al ruolo della stazione nella rete, alla collocazione territoriale e allo stato dei manufatti. Sulla base di tale lettura vengono definiti indirizzi operativi e scenari di trasformazione coerenti con la configurazione del nodo.

Il metodo così articolato consente di passare dalla ricognizione analitica del Patrimonio a una programmazione selettiva degli interventi, garantendo la comparabilità su scala di rete e l'adattabilità ai singoli casi. Pur applicato alla sola rete lombarda di Ferrovie Nord risulta trasferibile a comparti analoghi: sono trasferibili in particolare la struttura in tre fasi, le macroaree di valutazione e l'integrazione tra analisi, partecipazione e indirizzi operativi, mentre restano specifici del caso Ferrovie Nord alcuni dispositivi classificatori (ranking e manuali interni) e la disponibilità di dati proprietari, sostituibili in altri contesti con sistemi equivalenti.

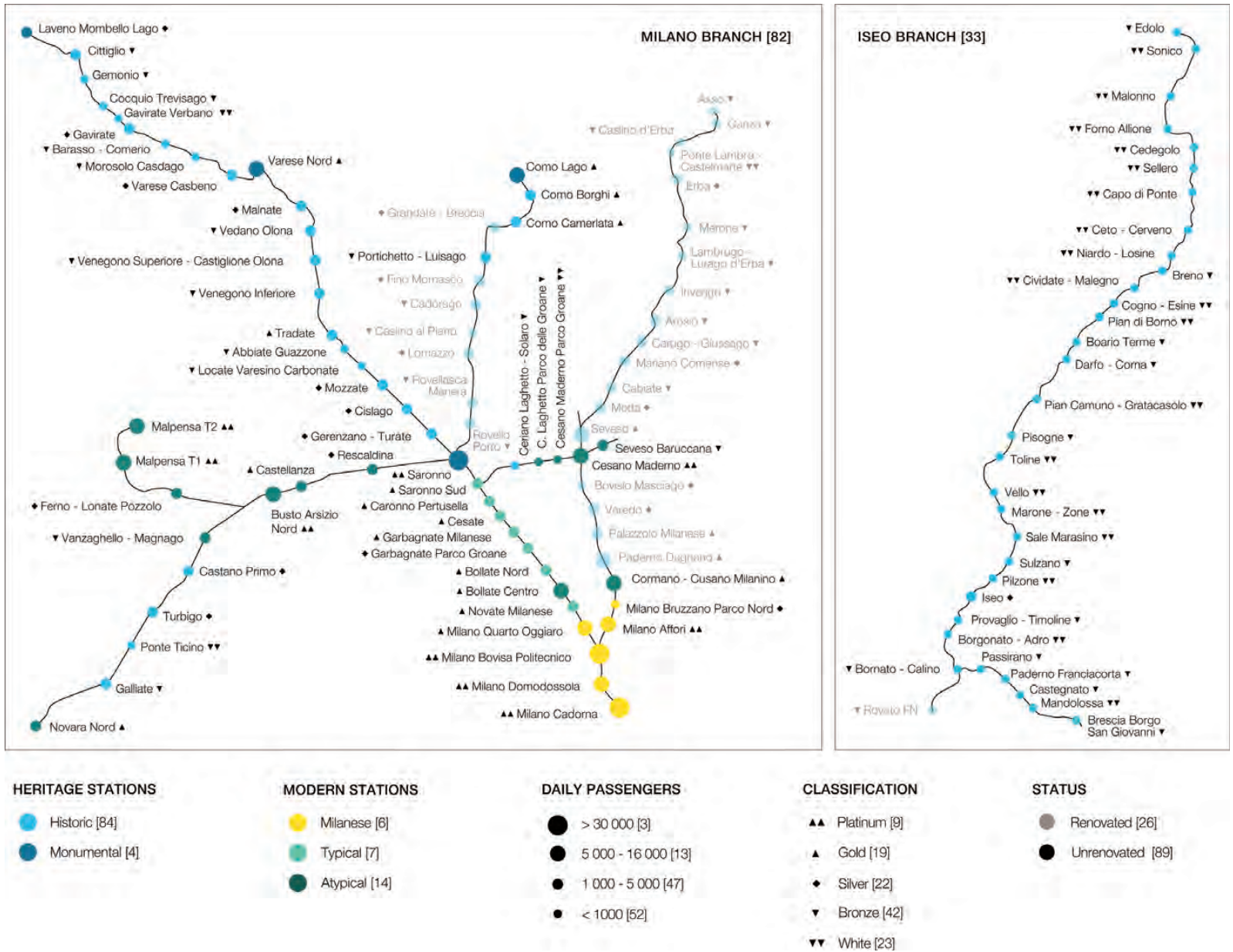


Fig. 2 | Mapping of the FN network (credit: the Authors, 2026).

Milano Cadorna: un caso applicativo | La stazione di Milano Cadorna è uno dei nodi storici e strategici del sistema ferroviario lombardo. Situata nel cuore del sistema urbano milanese, svolge un ruolo intermodale primario, integrando le linee ferroviarie del Ramo Milano di Ferrovie Nord, due linee metropolitane, il trasporto pubblico di superficie e numerosi percorsi ciclopedonali urbani. La sua stratificazione storica, costituita da un primo manufatto ottocentesco e da alcune trasformazioni avvenute nel periodo bellico e post-bellico, è tutt'oggi leggibile nei caratteri architettonici non omogenei del complesso (Fig. 4). Gli interventi avviati negli anni Duemila, tra cui la controfacciata del Palazzo progettata da Gae Aulenti e gli adeguamenti interni della stazione (Fig. 5), hanno ridefinito l'immagine contemporanea del comparto, lasciando tuttavia aperte criticità relative alla qualità spaziale, alla gestione dei flussi e all'adeguamento tecnologico e normativo (Cornò, 2006). Inoltre si evidenzia la necessità di coniugare la rigenerazione urbana dell'intero comparto con gli obiettivi del Piano Strategico del gruppo Ferrovie Nord Milano (FNM), con particolare riferimento alla qualità e alla sostenibilità am-

bientale (Figg. 6-8); al comparto di Cadorna è stato applicato lo strumento multicriteriale presentato.

La fase della 'prevalutazione' ha definito Cadorna come 'stazione moderna', con ranking 'platinum' e inquadramento territoriale urbano. Il numero di passeggeri giornalieri è pari a 65.490; i risultati sono stati costruiti a partire dagli indicatori e dalle evidenze riportate nella Tabella 2.

Sotto il profilo della 'accessibilità e intermodalità' la stazione presenta un elevato livello di integrazione modale, sebbene permangano diverse criticità nella leggibilità dei percorsi e nella gestione dei flussi: numerosi dislivelli limitano l'accessibilità universale tra metropolitana, atrio e banchine, nonché tra banchine e treni (Fig. 9). Nella macroarea 'funzionalità e prossimità' emerge una buona dotazione di servizi commerciali e di supporto alla mobilità, a fronte di una presenza limitata di funzioni civiche e di spazi di prossimità non commerciali, i quali risulterebbero significativi in relazione al contesto di riferimento (Fig. 10); la presenza di spazi inutilizzati o degradati evidenzia al contempo significative potenzialità di attivazione. In termini di 'sostenibilità ambientale e sociale' l'analisi ha eviden-

ziato ampi margini di miglioramento nelle aree esterne, con particolare riferimento alle estese superfici impermeabili e alla scarsa qualità microclimatica (Fig. 11).

La macroarea 'qualità spaziale' ha evidenziato forti criticità nel fabbricato viaggiatori prospiciente il piazzale Cadorna (spazi degradati o sottoutilizzati, percezione di congestione, scarsa organizzazione della cartellonistica e scarsa integrazione dei sistemi audio-video) e nelle banchine (degrado dei materiali e necessità di adeguamento normativo). All'interno del comparto sono inoltre presenti ulteriori manufatti ad uso ferroviario e uffici (Palazzina Movimento e Palazzina Ingegneria), il cui stato manufattivo e prossimità ai binari, in particolare della Palazzina Movimento, incidono negativamente sulla qualità urbana del comparto. Rispetto alla 'sicurezza', pur essendo quasi costantemente presidiata, la Stazione presenta criticità negli spazi limitrofi alla piazza (Tab. 3).

In coerenza con l'impianto metodologico delineato, il profilo emerso dalla checklist è stato quindi approfondito mediante indagini tecnico-specialistiche mirate, attivate in ragione della complessità

del comparto e della sua stratificazione storica. Data la natura del caso studio la valutazione complessiva è stata infatti supportata da analisi relative agli aspetti trasportistici, strutturali, statici e geofisici, finalizzate a verificare le condizioni del fabbricato esistente e le effettive possibilità di intervento (Tab. 4).

La fase partecipativa è stata articolata in tavoli istituzionali con le diverse società del gruppo FNM operanti nella stazione e con Regione Lombardia, attraverso incontri strutturati e focus group. In particolare i tavoli di lavoro sono stati organizzati per ambiti tematici e livelli decisionali: tavoli regionali finalizzati alla definizione del quadro esigenziale complessivo; tavoli tecnici per l'approfondimento dello stato dei fabbricati e delle condizioni infrastrutturali; tavoli con i referenti delle diverse direzioni del gruppo (sostenibilità, funzionalità, servizio ferroviario) per l'individuazione di criticità e opportunità specifiche.

Tale processo ha contribuito alla definizione di un quadro esigenziale condiviso, orientato principalmente al rafforzamento dell'intermodalità, alla riqualificazione degli spazi pubblici e alla valorizzazione ambientale del comparto. I tavoli con i gestori dell'infrastruttura hanno evidenziato esigenze spaziali e funzionali specifiche, configurando Cadorna come caso peculiare di ibridazione tra spazi ferroviari e di lavoro, caratterizzati da una stretta interrelazione fisica e gestionale. È stato inoltre predisposto un questionario rivolto agli utenti e alla popolazione che frequenta il comparto, finalizzato a rilevare le modalità d'uso e i bisogni emergenti.⁸

Infine gli esiti della checklist e delle analisi tecnico-specialistiche, basati su evidenze verificabili,

sono stati tradotti in indirizzi operativi e in priorità di intervento. Data la complessità e l'estensione del comparto (circa 58.000 mq), sono stati individuati i sottoambiti di riferimento, omogenei per carattere e tipologia (Fig. 12), per ciascuno dei quali sono stati definiti gli indirizzi specifici e le azioni prioritarie, a partire dalla correlazione tra i livelli emersi nelle macroaree e la matrice di posizionamento definita in fase di prevalutazione (Tab. 5).

Per il fabbricato viaggiatori (Area A – 4.545 mq), le criticità riscontrate orientano verso una riorganizzazione funzionale e spaziale dell'atrio e degli ambienti interni, finalizzata a migliorare gli accessi e la gestione dei flussi, a potenziare le aree di attesa e a rifunzionalizzare gli spazi inutilizzati. Gli interventi sulle volumetrie e sulla copertura della volta dovranno essere valutati in relazione agli esiti delle verifiche strutturali e ai vincoli di tutela, integrando le istanze di conservazione e di adeguamento funzionale. Per l'area delle banchine (Area B – 14.670 mq) gli esiti delle analisi indirizzano verso adeguamenti volti all'accessibilità universale dei treni e delle banchine, al miglioramento delle prestazioni ambientali e al rinnovo delle pavimentazioni e delle pensiline, in coerenza con l'identità complessiva della stazione.

Per l'area delle Palazzine (Area C – 8.170 mq), gli indirizzi invitano a migliorare la fruibilità dell'area e la connessione con il fabbricato viaggiatori, nonché a una profonda riqualificazione degli immobili ad uso ufficio (Palazzina Movimento e Palazzina Ingegneria) e dei loro spazi esterni di pertinenza, al fine di aumentare la qualità urbana e ambientale

dell'area. Per l'area sottoponte e parcheggi (Area D – 20.810 mq) le criticità relative alla sostenibilità orientano verso interventi di miglioramento della fruibilità pedonale, incremento della qualità ambientale e azioni per la mitigazione del microclima e dell'inquinamento acustico, nonché la riorganizzazione delle superfici oggi destinate a parcheggio a raso.

Oltre agli indirizzi di intervento sui singoli ambiti è emersa la necessità di rafforzare la relazione sistemica tra la stazione e la città, con particolare riferimento al potenziamento della mobilità ciclabile, dell'interscambio multimodale e della qualità degli spazi pubblici limitrofi (Area E). Tali azioni estenderebbero la rigenerazione oltre il perimetro ferroviario, configurando Cadorna come infrastruttura urbana integrata, capace di contribuire all'accessibilità diffusa e alla qualità dello spazio pubblico in una prospettiva di equità territoriale.

A corollario dell'analisi sono state sviluppate alcune possibili traduzioni spaziali degli esiti analitici emersi, che non costituiscono evidenza del metodo, ma rappresentano una possibile visione progettuale degli indirizzi individuati, riferita ad alcuni elementi specifici del comparto (Figg. 13, 14).

Discussione: sinergie, compromessi, trasferibilità | Il contributo evidenza come la rigenerazione dei comparti ferroviari richieda sinergie strutturate tra le proprietà dei Patrimoni infrastrutturali, le Amministrazioni pubbliche, gli Enti locali, gli investitori privati e le comunità locali. La natura ibrida della stazione – nodo tecnico e spazio pubblico – implica la necessità di conciliare istanze differenti, tra cui la

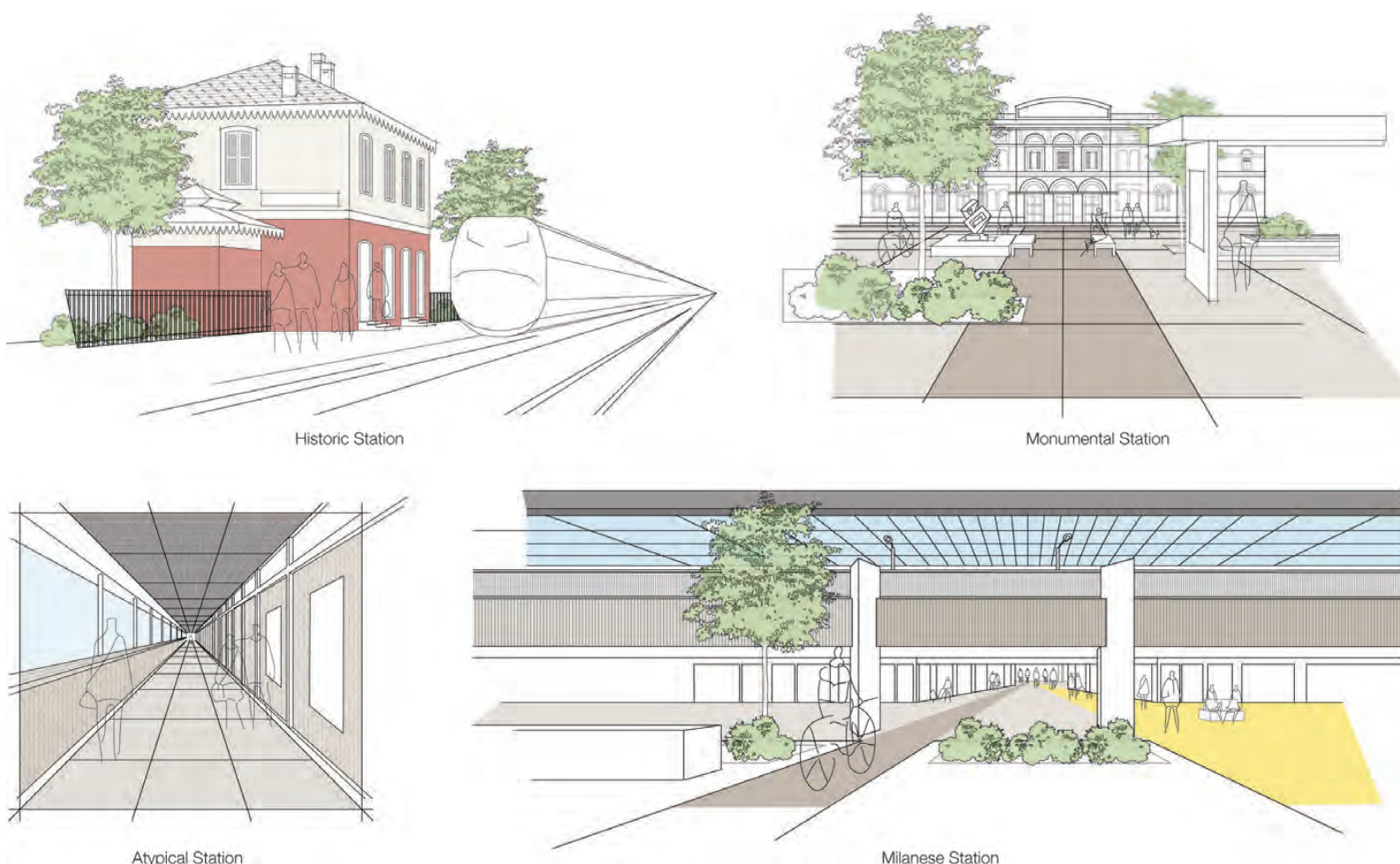


Fig. 3 | Examples of station typologies and characters (credit: the Authors, 2026).



Fig. 4 | Historical sequence of Milano Cadorna Station (Italy): historical photos (credits: FNM Group).

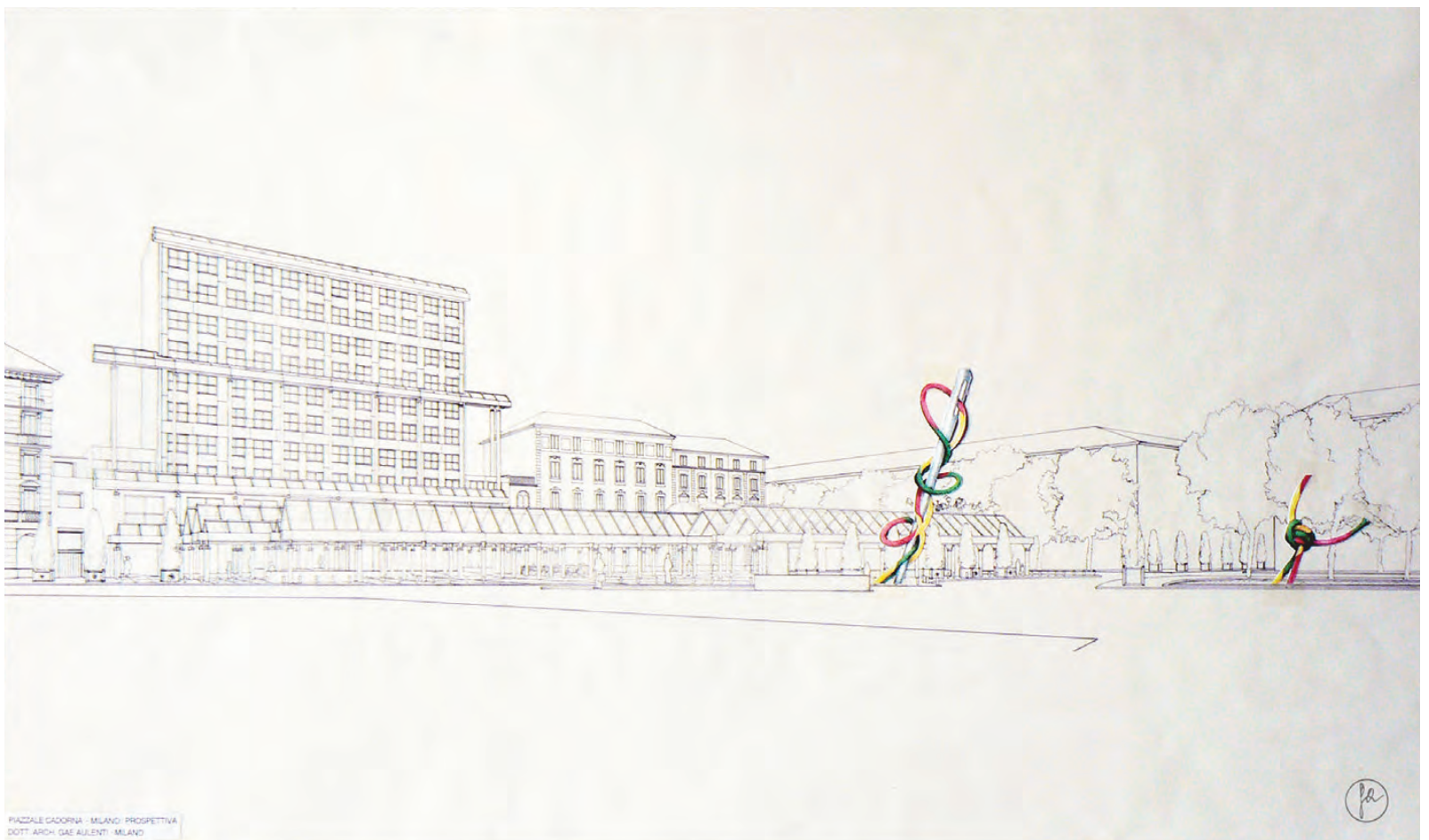


Fig. 5 | Sketch of the new Piazzale Milano Cadorna (2000), designed by Gae Aulenti (source: Lombardia Beni Culturali Online Archive).

Fig. 6, 7 | Aerial views of the Milano Cadorna station (credits: Google; M. P. Vettori, 2026).



Fig. 8 | Milano Cadorna station and adjacent station building: current state (credit: M. P. Vettori, 2026).

A. MULTIMODALITY AND ACCESSIBILITY

Criterion	Indicator	Evidence	Assessment	Data source	Data type	No. of indicators satisfied	% indicators satisfied	Outcome
A1. Modal integration	Surface public transport	Presence of at least one surface public transport mode within 500 m	TRUE	Analysis of ATM network data, urban mapping	Documentary	5	83.33%	HIGH
	Underground	Presence of at least one underground line within 500 m	TRUE	Analysis of ATM network data, MM, urban mapping	Documentary			
	Cycle infrastructure	Direct connection to the urban or territorial cycle network	TRUE	Analysis of data from the Municipality of Milan	Documentary			
	Cycling mobility services	Presence of at least two cycling mobility services (cycle hub, bicycle parking, and bike sharing)	FALSE	Analysis of data from the Municipality of Milan, BikeMI, PUMS, and survey	Documentary, observational			
	Interchange and parking facilities	Presence of interchange car parks or dedicated parking areas near the station	TRUE	Analysis of data from the Municipality of Milan and survey	Documentary, observational			
	Taxi stands	Presence of taxi stands	TRUE	Direct survey	Observational			
A2. Universal accessibility	Access systems to platforms	Access to platforms guaranteed by diversified systems (fixed stairs, escalators, lifts, and ramps)	FALSE	Ferrovie Nord cartography, survey	Cartographic, observational	0	0%	LOW
	Access control	Number and type of ticket barriers adequate for passenger flows, where present	FALSE	FN and Trenord data analysis, flow analysis, direct survey	Documentary, observational			
	Architectural barriers	Absence of architectural barriers within the station	FALSE	Direct survey, technical documentation	Observational			
	Routes for visually impaired users	Presence of tactile paving integrated into the floor surface (LOGES) and systems for visually impaired users	FALSE	Direct survey	Observational			
	Separation and clarity of flows	Separation and clarity of pedestrian and cycle-pedestrian flows	FALSE	Direct survey, flow analysis	Observational			
A3. Urban continuity	Urban underpasses and overpasses	Presence of underpasses or overpasses connecting neighbouring districts	FALSE	Milan Municipal Technical Map, survey	Cartographic, observational	1	33.33%	LOW
	Connection with public spaces	Direct connection with usable public spaces (squares and gardens)	TRUE	Milan Municipal Technical Map, survey	Cartographic, observational			
	Physical barriers to urban continuity	Absence of physical barriers (fences and walls) interrupting urban continuity	FALSE	Milan Municipal Technical Map, survey	Cartographic, observational			

B. FUNCTIONALITY AND PROXIMITY

Criterion	Indicator	Evidence	Assessment	Data source	Data type	No. of indicators satisfied	% indicators satisfied	Outcome
B1. Passenger services	Ticketing	Presence of ticketing systems, either automatic or staffed	TRUE	Direct survey, Trenord service documentation, FN	Observational, documentary	4	80%	HIGH
	Toilets	Presence of accessible toilets	TRUE	Direct survey, cartographic documentation	Observational, documentary			
	Waiting areas	Presence of waiting areas in the passenger building and on the platforms	FALSE	Direct survey, spatial analysis	Observational			
	Food and retail services	Presence of food or retail services	TRUE	Analysis of commercial data and FN space leases, direct survey	Documentary, observational			
	Lockers and integrated digital services	Presence of pick-up / locker systems or integrated digital services	TRUE	Analysis of FN concessions, direct survey	Documentary, observational			
B2. Civic and proximity services	Civic and public services	Presence of civic or public services (healthcare facilities, help desks, and information points)	TRUE	Analysis of FN space leases, direct survey	Documentary, observational	1	25%	LOW
	Cultural and associative functions	Presence of cultural or associative functions	FALSE	Analysis of FN space leases, direct survey	Documentary, observational			
	Social and inclusive services	Presence of social or inclusion-oriented services	FALSE	Analysis of FN space leases, direct survey	Documentary, observational			
	Territorial enhancement activities	Presence of activities enhancing local economies or territorial supply chains	FALSE	Analysis of FN space leases, direct survey, stakeholder interviews	Documentary, observational, interviews			
B3. Integration with the surrounding context	Commercial and proximity services	Presence of commercial activities and services within 200 m of the station	TRUE	Analysis of FN space leases, direct survey	Documentary, observational	3	100%	HIGH
	Cultural and tourist attractors	Presence of cultural or tourist attractors within 500 m of the station	TRUE	Urban analysis, Municipality of Milan cartography, survey	Documentary, observational			
	High-value landscape and environmental contexts	Presence of high-value landscape or environmental contexts near the station	TRUE	Territorial analysis, Municipality of Milan data, GIS	Documentary			

Tabb. 2a, 2b | Multi-criteria analysis checklist and application to Milano Cadorna station (credit: the Authors, 2026).

C. ENVIRONMENTAL AND SOCIAL SUSTAINABILITY

Criterion	Indicator	Evidence	Assessment	Data source	Data type	No. of indicators satisfied	% indicators satisfied	Outcome
C1. Environmental performance of the facility	Energy from renewable sources	Presence of systems for producing or using energy from renewable sources	FALSE	Technical documentation, FN manager data	Documentary	0	0%	LOW
	Energy saving	Presence of energy-saving solutions (efficient lighting and smart systems)	FALSE	Direct survey, FN technical documentation, and NordIng	Documentary, observational			
	Management and reuse of rainwater	Presence of solutions for the management and reuse of rainwater	FALSE	Map analysis and FN technical documentation	Documentary			
	Acoustic mitigation	Presence of solutions for mitigating noise pollution in railway areas	FALSE	Direct survey and technical documentation	Documentary, observational			
	Microclimatic mitigation	Presence of microclimatic mitigation solutions (greenery, shading, permeable surfaces, and fountains)	FALSE	Map analysis and direct survey	Documentary, observational			
C2. Sustainable management of spaces	Environmental protocols and certifications	Presence of environmental protocols or certifications	FALSE	Official FN documentation	Documentary	1	33.33%	LOW
	Waste management	Presence of waste management systems for separate collection and waste reduction	TRUE	Direct survey, FN technical documentation, and NordIng	Observational, documentary			
	Environmental impact	Presence of low-impact materials or design solutions	FALSE	Direct survey, material analysis, and technical documentation	Observational, documentary			
C3. Social impact and inclusion	Participation and co-design	Presence of structured participation and co-design processes	FALSE	Working group minutes and process documentation	Documentary	2	33.33%	LOW
	Institutional and territorial partnerships	Presence of active partnerships between the railway operator, public administrations, and the third sector	TRUE	Official documentation on current agreements and FN concessions; working groups with stakeholders	Documentary, interviews			
	Highly accessible public services	Presence of highly accessible public services (healthcare services and neighbourhood services)	TRUE	Service analysis and lease documentation	Documentary			
	Meeting and socialising spaces	Presence of usable meeting and socialising spaces (association spaces, volunteering spaces, and event spaces)	FALSE	Direct survey, interviews, and questionnaires	Observational, interviews			
	Territorial attractiveness initiatives	Activation of territorial attractiveness initiatives (events, exhibitions, and information activities)	FALSE	Station event planning and interviews	Documentary, interviews			
Services for people in vulnerable conditions	Presence of services or help desks for people in vulnerable conditions (minors, homeless people, listening centres, housing support, and disability support)	FALSE	Station services analysis and interviews	Documentary, participatory				

D. SPATIAL QUALITY

Criterion	Indicator	Evidence	Assessment	Data source	Data type	No. of indicators satisfied	% indicators satisfied	Outcome
D1. Maintenance condition and physical integrity	Structural integrity of buildings and canopies	Absence of evident structural decay in passenger buildings	FALSE	Direct survey, specialist investigations, and technical documentation	Cartographic, documentary	0	0%	LOW
	Seismic upgrading of buildings and canopies	Compliance with current seismic regulations	FALSE	Direct survey, specialist investigations, and technical documentation	Cartographic, documentary			
	Disused spaces	Absence of unused or abandoned spaces	FALSE	Direct survey	Observational			
	Conservation of materials and finishes	Absence of visibly obsolete or deteriorated materials or finishes	FALSE	Direct survey and specialist investigations	Observational, documentary			
D2. Perceptual quality of the station building	Information systems	Presence of an integrated audio-visual information system	TRUE	Direct survey	Observational	2	50%	MEDIUM
	Waiting areas	Presence of adequately sized and covered waiting areas	FALSE	Spatial analysis, direct survey, and questionnaires	Observational, interviews			
	Signage	Clarity of access points and connections	FALSE	Direct survey	Observational			
D3. Quality of adjacent public spaces	Continuity and usability from outside	Visual continuity between the station and the external public space	TRUE	Direct survey and questionnaires	Observational, interviews	2	66.67%	MEDIUM
	Public spaces	Presence of usable public spaces (squares, gardens, and pedestrian routes)	TRUE	Direct survey, cartographic analysis	Observational, documentary			
	Degradation of public spaces	Absence of visibly degraded public spaces immediately adjacent to the station	FALSE	Direct survey	Observational			
	Disused properties	Absence of abandoned or underutilised buildings near the station	TRUE	Direct survey, FN documentation	Observational, documentary			

Tabb. 2c, 2d | Multi-criteria analysis checklist and application to Milano Cadorna station (credit: the Authors, 2026).

E. SAFETY AND SURVEILLANCE

Criterion	Indicator	Evidence	Assessment	Data source	Data type	No. of indicators satisfied	% indicators satisfied	Outcome
E1. Perceived safety and lighting	Lighting of internal spaces	Presence of adequate lighting in the internal spaces of the passenger building	TRUE	Direct survey, cartographic analysis	Observational, documentary	2	50%	MEDIUM
	Lighting of external spaces	Presence of adequate lighting in external spaces (square, car parks, underpasses, and platforms)	FALSE	Direct survey, cartographic analysis	Observational, documentary			
	Functional presence	Presence of activities and services operating throughout the day	TRUE	Direct survey, commercial data analysis, and FN space leasing	Observational, documentary			
	Blind spots	Absence of blind spots or spaces that are not visible along the main routes	FALSE	Direct survey	Observational			
E2. Control and management systems	Vide surveillance	Presence of video surveillance systems	TRUE	Official FN documentation, interviews	Observational, participatory	3	75%	HIGH
	Staff and active forms of presence	Presence of staff or active forms of presence, including shared arrangements with other bodies	TRUE	Direct survey, interviews, and FN management documentation	Observational, participatory			
	Emergency procedures	Presence of clearly signposted emergency procedures	FALSE	Direct survey, FN safety documentation	Observational, documentary			
	Closing and protection systems	Presence of systems for closing or regulating access at night	TRUE	Direct survey and interviews	Observational, interviews			

Tab. 2e | Multi-criteria analysis checklist and application to Milano Cadorna station (credit: the Authors, 2026).

valorizzazione patrimoniale, l'adeguamento infrastrutturale, la sostenibilità economica e le funzioni di prossimità, non sempre convergenti.

L'applicazione del metodo multicriteriale ha mostrato come tali sinergie generino inevitabili compromessi: l'incremento dell'intermodalità comporta ridefinizioni spaziali complesse; l'inserimento di nuove funzioni di prossimità può entrare in tensione con i modelli di valorizzazione immobiliare; la tutela del Patrimonio storico può limitare interventi di efficientamento energetico o ampliamento volumetrico. La lettura per macroaree consente di rendere esplicite tali dinamiche e di orientare scelte programmatiche consapevoli su scala di rete, integrando innovazione infrastrutturale e attenzione alla coesione territoriale. Questa impostazione si avvicina agli approcci di previsione strategica urbana che, a scala europea, enfatizzano la costruzione di visioni condivise e di scenari di lungo periodo per le infrastrutture e i territori (Mantziaras, 2024).

I limiti dello studio sono legati alla diversa maturità operativa delle stazioni analizzate: mentre alcuni nodi presentano programmi già avviati, molte stazioni si collocano ancora in fase di visione strategica, rendendo verificabile il metodo soprattutto in termini di orientamento programmatico e non ancora di monitoraggio ex post degli esiti. Attualmente il metodo è stato applicato solo al caso di Cadorna, ma è in corso di validazione sulle stazioni dell'hinterland milanese della linea Milano-Saronno. Ulteriori criticità riguardano la disponibilità e l'omogeneità dei dati, non sempre garantite in contesti meno strutturati, nonché la scelta di privilegiare una valutazione qualitativa multicriteriale, che favorisce l'applicabilità e l'adattabilità, ma non consente una misurazione quantitativa standardizzata degli impatti.

La diffusione di un approccio sistemico alla rigenerazione delle stazioni incontra inoltre barriere

di natura culturale, economica e istituzionale. Permane una lettura della stazione come mera infrastruttura tecnica, mentre la frammentazione proprietaria e la rigidità dei modelli concessori possono ostacolare interventi integrati; la complessità normativa e la presenza di vincoli di tutela richiedono forme di governance multilivello stabili e coordinate. In tale quadro il metodo proposto si configura come strumento adattabile a reti ferroviarie regionali caratterizzate da Patrimoni diffusi e strutture concessorie analoghe, grazie alla sua articolazione modulare – mappatura, checklist, analisi mirate e partecipazione – che consente comparabilità su scala di rete e flessibilità nei diversi contesti.

In relazione agli obiettivi di sviluppo sostenibile l'approccio metodologico proposto contribuisce direttamente al rafforzamento delle infrastrutture resilienti (SDG 9), alla riduzione delle disuguaglianze territoriali (SDG 10), alla qualità urbana e alla rigenerazione sostenibile (SDG 11) e alla mitigazione degli impatti ambientali (SDG 13). Tali contributi si accompagnano a effetti indiretti su altri ambiti, in particolare sul benessere urbano (SDG 3), sull'accesso equo ai servizi e alle opportunità (SDG 1), sulla qualità degli spazi pubblici e dell'abitare (SDG 16) e sul rafforzamento di forme di cooperazione tra attori pubblici e privati (SDG 17), generando sinergie tra mobilità, spazio pubblico e inclusione sociale. Al contempo l'approccio metodologico evidenzia possibili compromessi tra efficienza economica, tutela del Patrimonio e obiettivi ambientali, la cui gestione richiede adeguati livelli di governance, disponibilità di dati e coordinamento tra gli attori coinvolti.

Conclusioni | La ricerca contribuisce al dibattito sulla rigenerazione delle stazioni ferroviarie proponendo una loro lettura come infrastrutture territoriali di prossimità, capaci di integrare dimensione infra-

strutturale, qualità spaziale, servizi e inclusione sociale su scala di rete. In particolare il contributo introduce un metodo multicriteriale che traduce in forma operativa le principali dimensioni emerse dalla letteratura recente sulla 'rigenerazione delle aree delle stazioni' rispetto a intermodalità, prossimità, sostenibilità e governance, superando approcci settoriali e proponendo una struttura comparativa applicabile a contesti eterogenei.

In un contesto quale quello europeo e italiano, caratterizzato dalla presenza diffusa di stazioni che richiedono interventi di adeguamento infrastrutturale, funzionale e ambientale, l'approccio metodologico presentato consente di passare da una lettura descrittiva delle criticità a una loro organizzazione in priorità e in indirizzi operativi, supportando processi decisionali più consapevoli nella programmazione degli interventi. In questo senso il contributo si configura non solo come strumento analitico, ma anche come dispositivo di supporto alla pianificazione strategica, capace di connettere le dimensioni infrastrutturale e urbana.

Dal punto di vista della trasferibilità il metodo risulta applicabile a reti ferroviarie caratterizzate da Patrimoni diffusi e da differenti condizioni di governance, grazie alla sua struttura modulare e adattabile. La sua applicazione richiede tuttavia alcune condizioni di base, quali la disponibilità di dati minimi, la presenza di sistemi di classificazione e la collaborazione tra i soggetti gestori, le Amministrazioni locali e gli attori territoriali.

Sul piano dell'agenda di ricerca lo studio apre ulteriori sviluppi, in particolare nell'integrazione di indicatori qualitativi e quantitativi nell'analisi e nella valutazione di manufatti esistenti, nell'approfondimento dei modelli di governance multilivello per la gestione dei processi di rigenerazione urbana e ferroviaria, nella definizione di sistemi di monitoraggio ex post degli impatti sociali e ambientali e infine

nell'approfondimento di metodi e processi per il riuso adattivo di spazi e patrimoni ferroviari in trasformazione. In tale prospettiva le stazioni ferroviarie si configurano come dispositivi centrali per la transizione ecologica e sociale delle città contemporanee, contribuendo a orientare le politiche verso sistemi di mobilità più equi, spazi pubblici più inclusivi e una maggiore coesione territoriale.

Since their nineteenth-century expansion, railway networks and their infrastructural nodes have constituted devices that have shaped the European urban structure, organising spatial, economic, and social relationships at the territorial scale. In contemporary contexts, these nodes are no longer exclusively places of transit, but rather multi-scalar environments required to redefine their role across technical efficiency, the quality of public space, and new demands for inclusion and sustainability, within a renewed relationship between infrastructure and city. Railway stations have progressively expanded their functions and urban meanings, evolving from monumental logistical nodes and catalysts of nineteenth-century industrial growth (Meeks, 1995; Bertolini and Spit, 1998) to multifunctional hubs and actors in territorial regeneration from the 1980s and 1990s onwards (Cervero, 1998; Bertolini, 1996; 1999; Peters and Novy, 2012).

The literature review was conducted through the analysis of recent scientific contributions and

national and international institutional documents on the regeneration of stations and mobility systems, selected according to the dimensions of accessibility, intermodality, proximity, sustainability, and governance. The review aimed to identify interpretative and operational models to construct the theoretical framework and define the analytical dimensions underlying the proposed method.

The recent transformation of stations has involved the integration of service and proximity functions, as well as the adoption of standards for social inclusion (Ricci, Poli and Marino, 2025; Cancelli, 2025), in continuity with planning approaches such as Transit-Oriented Development (TOD), which promote mixed-use densification and sustainable accessibility (Cervero, 1998; Bertolini, 1999; Banerjee and Saha, 2022), and with interpretations of the station as a node of inclusion (Canesa and Centanaro, 2024). The paradigm of the 15-minute city has further reinforced the potential of stations as local nodes for essential services, with impacts on quality of life, compatible densification, and the distribution of services across the territory (Ricci, Poli and Marino, 2025; Fiorini et alii, 2025; Otsuka and Reeve, 2024).

In the Italian context, the transformation of railway station areas develops along two main trajectories: the redevelopment of major stations as complex urban devices and the widespread reconversion of the existing heritage through practices of social reuse and proximity micro-hubs (RFI, 2015, 2022). Italian literature has primarily focused on as-

sessing the regenerative potential of stations in relation to urban policies and the symbolic and functional transformations of station spaces (Conticelli, 2011; Paone, 2023), while the diffusion of participatory practices has strengthened the role of local actors in defining public spaces and welfare services connected to stations (Campagnaro et alii, 2025).

Over the last two decades, digitalisation and increasing attention to sustainability have accelerated this transformation: smart upgrading processes (sensors, electronic ticketing, and information systems) and integrated mobility solutions (bike-sharing, park-and-ride facilities, and shared mobility) have improved operational efficiency and user experience, in line with policies aimed at reducing emissions and regenerating public spaces (UIC, 2017; Griffin and Sener, 2016; ITF, 2015; European Commission, 2011).

Within this perspective, some studies have highlighted how the future of stations is characterised by a progressive blurring of boundaries between building and city, between public space and infrastructure, configuring multimodal nodes as porous environments that place people at the centre and are capable of integrating urban functions, services, and digital systems (ARUP, 2019, 2020). The station has progressively been considered a key actor in citizens' active mobility, contributing to the development of neighbourhoods and more equitable contexts (ARUP, 2022): recent experiences highlight the role of small hubs and multi-

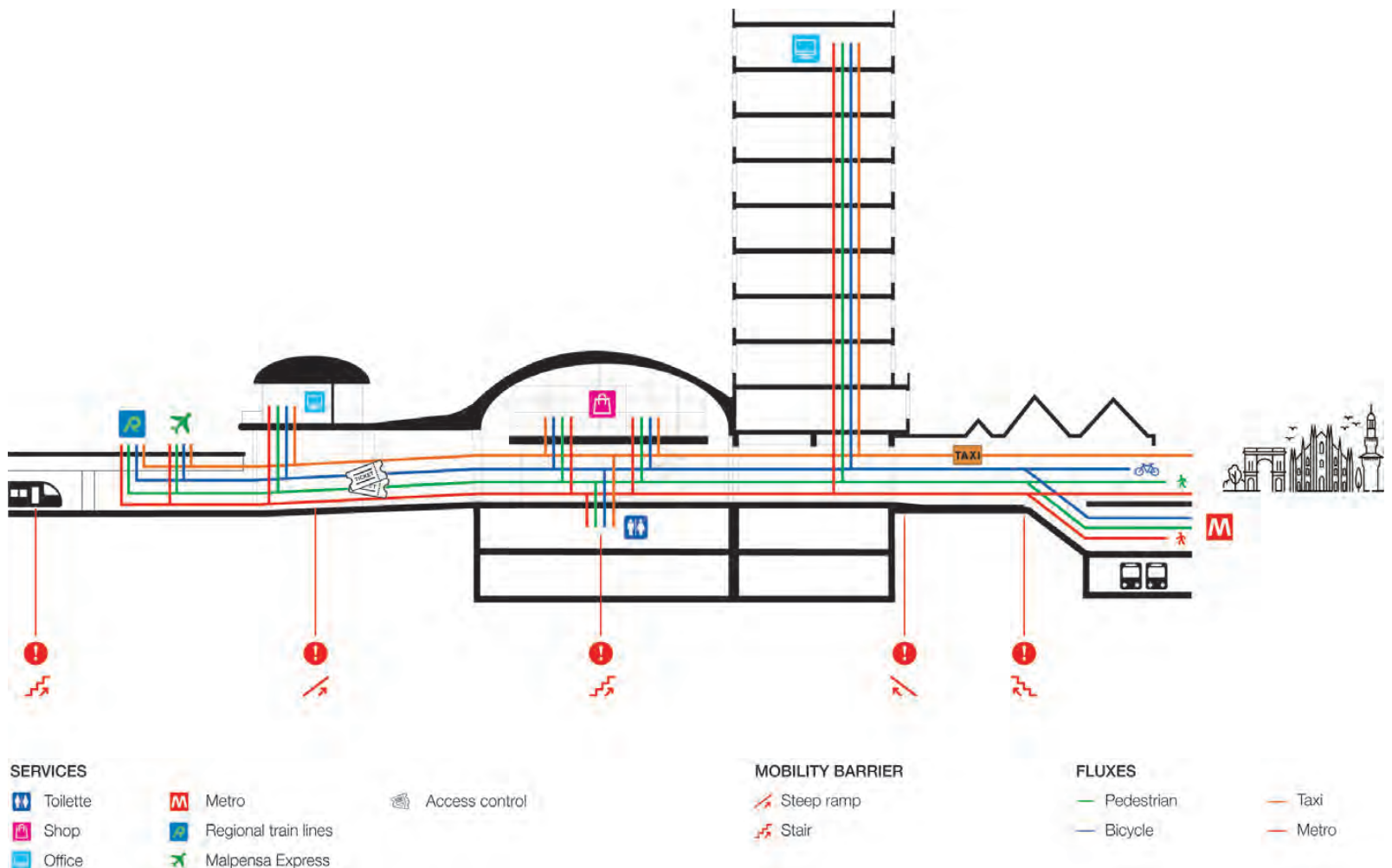
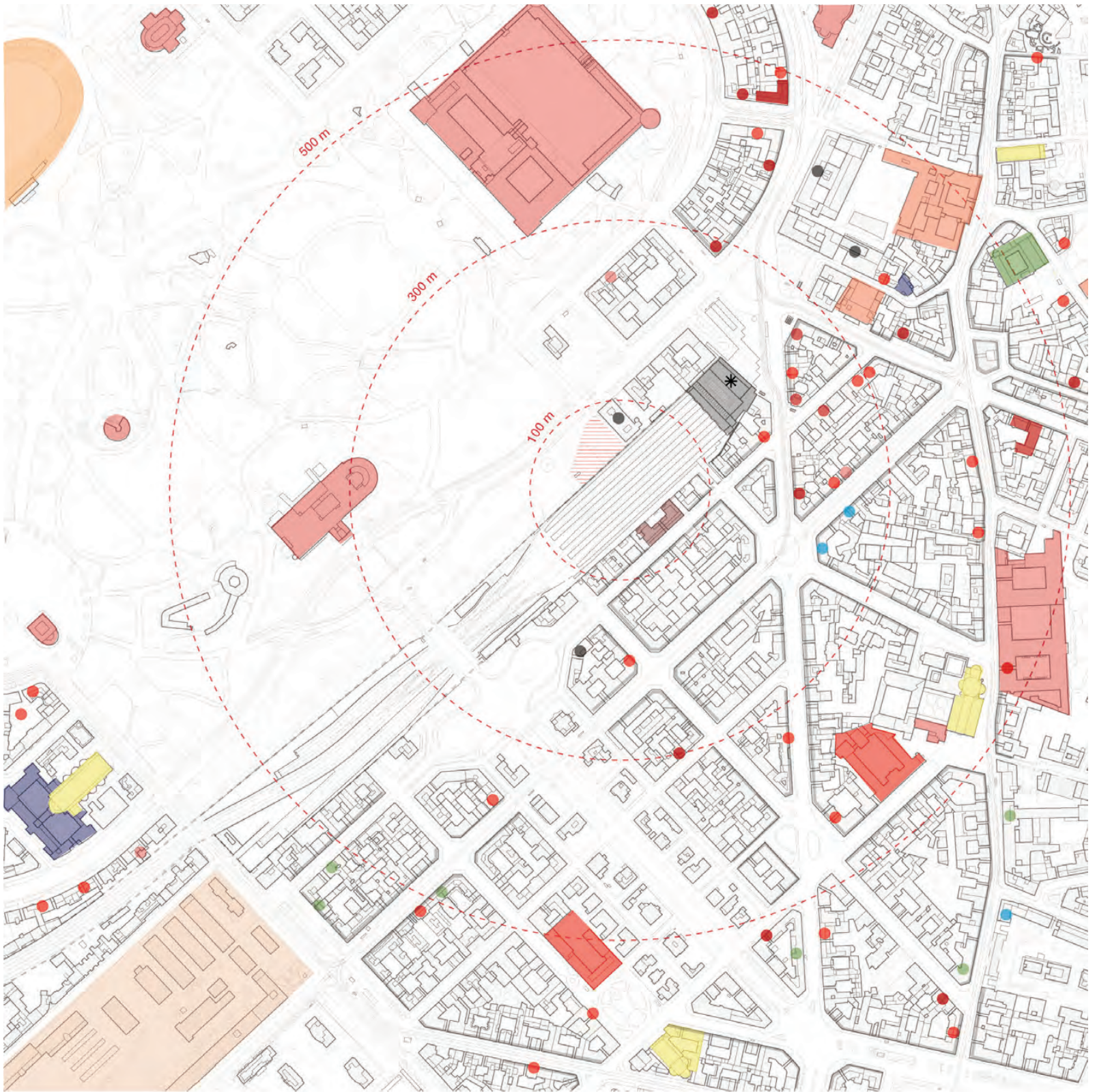


Fig. 9 | Milano Cadorna Station: section of the station and diagram of flows and accessibility (credit: the Authors, 2026).



EXISTING SERVICES

- | | | | |
|--|--|--|--|
| ● Culture [11] | ● Education [27] | ● Health [3] | — Commercial |
| ● Justice [1] | ● Social services [2] | ● Station [1] | ✱ Opportunity |
| ● University [5] | ● Religious facilities [4] | ● Office [4] | |
| ● Administration [11] | ● Safety and civil protection [1] | ● Sport [1] | |

Fig. 10 | Map of the urban context of Milano Cadorna station with services and main urban public functions (credit: the Authors, 2026).

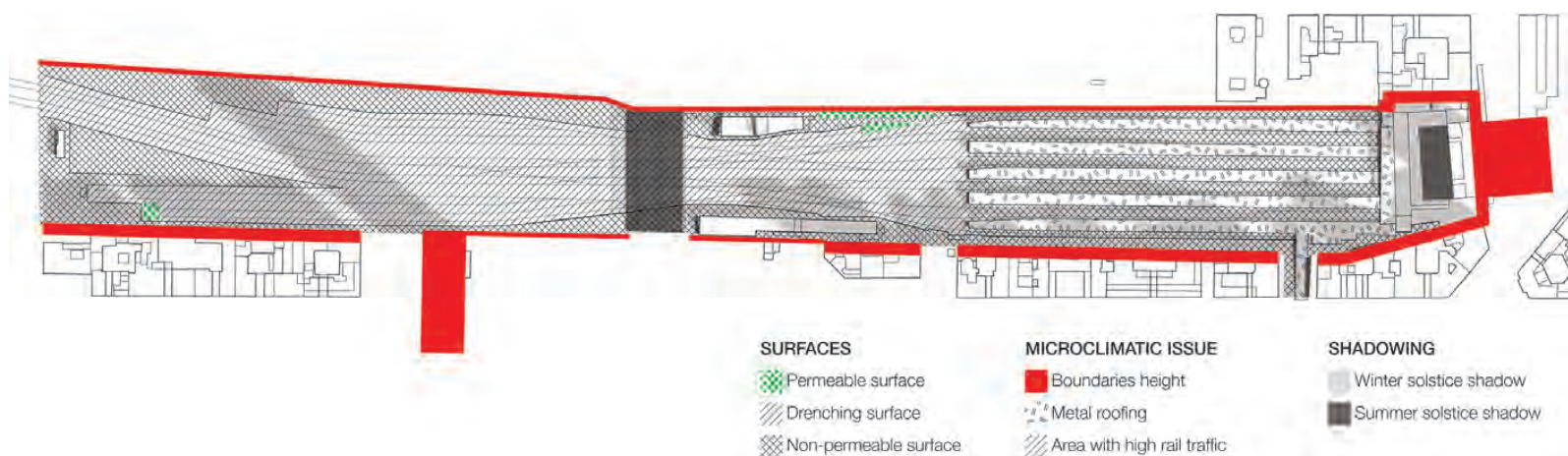


Fig. 11 | Map of impermeable surfaces and microclimatic criticalities (credit: the Authors, 2026).

functional micromobility devices as infrastructures connecting the railway node, public space, and urban services (Fabbri, 2023).

Empirical and analytical evidence indicate that infrastructural configurations and regeneration policies can contribute to spatial justice and sustainable development (Fiorini et alii, 2025; Cangelli, 2025), while participatory practices and civic presences reinforce the social and identity-related role of stations (Bertolini, le Clercq and Kapoen, 2005; Campagnaro et alii, 2025; Setola and Borgianni, 2025). However, significant challenges remain: the management and perception of safety, the reconciliation between heritage conservation and functional modernisation, the complexity of multi-level governance for integrated interventions (Berretta, Desideri and Staltari, 2024; Campagnaro et alii, 2025), and the obsolescence of technological systems. Looking ahead, stations are called upon to perform hybrid roles, acting as multimodal nodes and platforms for the ecological and social transition of cities, which requires interdisciplinary approaches for their understanding and governance (Bertolini, 1999; Cervero, 1998). Unlike perspectives that interpret the station primarily as a node (TOD, node-place model) or as a civic facility (social reuse), this contribution conceives the station as a territorial infrastructure of proximity, understood a spatial and social device distributed across the network scale. The originality of the paper lies in the proposal of a multi-criteria and multi-scalar tool that integrates infrastructural, spatial, and social dimensions into a comparative instrument oriented towards planning, bridging the gap between approaches focused solely on infrastructural performance and practices centred on localised social reuse. The study thus positions itself within the broader debate on smart and sustainable mobility infrastructures as a new system of urban connections, requiring the integration of technical performance, spatial quality, and environmental objectives (Bruno et alii, 2024).

In light of the outlined framework, the contribution presents the results of a research project aimed at interpreting railway stations as territorial infrastructures of proximity at the network scale, through the development of a tool applied to the Lombardy station system and tested in the case of Milano Cadorna (Italy). The research pursues three main objectives: 1) to construct a comparable knowledge framework of stations based on

infrastructural, spatial, and social dimensions; 2) to define a multi-criteria and multi-scalar tool capable of guiding regeneration choices; 3) to verify its effectiveness, through a complex case study, in supporting shared decision-making processes.

The methodological process is structured into three integrated phases: knowledge mapping of the Lombardy network; multi-criteria evaluation of stations; application to the Milano Cadorna case. Consistent with this structure, the text develops through a process that, after comparing selected European and Italian experiences of station regeneration, frames the Lombardy system as the field of application, presents the developed method, tests its operational applicability through the Milano Cadorna case study, and finally discusses the results in terms of critical issues, opportunities, and transferability.

Within this perspective, the contribution aims to offer the scientific community both a conceptual and an operational framework for interpreting stations as components of a distributed territorial infrastructure and for guiding their regeneration through a comparative, replicable tool. The contribution of the study lies, in particular, in the possibility of connecting systemic analysis, multi-criteria evaluation, and the definition of operational guidelines, thereby supporting policies and projects within a perspective of territorial equity, infrastructural integration, and the quality of public space.

Comparative experiences in station regeneration

The international and national reference cases were selected as expressions of two trajectories that are currently significant in European and Italian railway regeneration: on the one hand, models oriented towards the integration between infrastructure, urban development, and the quality of public space; on the other, models centred on social reuse and the widespread reactivation of existing heritage. In particular, the case of the Dutch railway system was selected because the Netherlands represents one of the most structured laboratories for the integration of transport and urban development, as demonstrated by the extensive scientific literature and abundant available documentation.

The comparison was conducted according to homogeneous criteria in order to identify the methodological dimensions most useful for constructing the proposed framework. The theoretical

foundation of this approach lies in the node-place model developed by Bertolini (1996; 1999), which interprets the station as a device where infrastructural accessibility (node value) and urban functional intensity (place value) intersect. The model, further developed and applied in the Dutch context by Peek, Bertolini and De Jonge (2006), has guided integrated planning policies and the evaluation of the development potential of station areas. The literature shows that this process is neither episodic nor recent: several studies document a phase of maturation characterised by the integration of infrastructural redevelopment, real estate development, and new urban functions (Bruinsma, 2009). From a comparative perspective, Peters and Novy (2012) situate these interventions within the broader framework of railway station area regeneration megaprojects, highlighting the potential tension between the sustainability of transport systems and urban competitiveness.

The Dutch model is based on a structured governance system involving Nederlandse Spoorwegen (NS), responsible for managing the property assets, and ProRail, the infrastructure manager, supported by policy tools such as Spoorbeeld and Het Stationsconcept¹ (Bureau Spoorbouwmeester, 2025). The NS Annual Reports (Nederlandse Spoorwegen, 2024) and the Transport Plan 2025 (Nederlandse Spoorwegen, 2025) demonstrate a network-based strategy oriented towards intermodality, spatial quality, and sustainability, applied to over 400 stations. Within these documents, the role of stations is reinterpreted as a catalyst for local public space, capable of fostering interactions between public mobility, cycling, services, and urban functions in proximity to railway nodes. From this framework, recurring operational dimensions emerge: multimodal accessibility, integration with urban public space, territorial attractiveness, environmental and spatial quality, circularity and sustainability, functional mix, and multi-level governance.

In the Italian context, the trajectory develops in different ways. Following the centralisation of control systems and the reduction of physical presence in stations, Rete Ferroviaria Italiana (RFI, 2015) initiated a policy of property reuse through the Stazioni Impresenziate Programme, which activates reconversion processes by granting free-use agreements to local authorities and third-sector organisations. In this framework, the station serves as

a territorial facility and civic infrastructure, hosting cultural, social, and proximity services. The report by Zandonai (2015) interprets these experiences as the activation of community assets, structuring the reuse cycle into phases that include governance, economic sustainability, and impact evaluation. From this perspective, regeneration cannot be reduced to mere physical redevelopment but is a process of social innovation involving public actors, property owners, and civil society organisations, thereby strengthening the station’s role as a territorial hub.

The comparison between European and Italian experiences highlights two complementary trajectories: on the one hand, a model oriented towards urban transformation and infrastructural performance, supported by a consolidated theoretical and institutional tradition; on the other, a widespread and socially oriented model centred on heritage reactivation and community innovation (Tab. 1). In particular, the Italian model prioritises the refunctionalisation of spaces, while remaining less structured in strengthening infrastructural elements, intermodality, and environmental sustainability from a network-scale territorial equity perspective.

In light of these findings and recent literature on the regeneration of station areas, there is a need for an approach that integrates infrastructural performance, spatial quality, functional proximity, and

network governance. Although these dimensions are widely recognised, in the analysed cases, they are typically addressed sectorally, alternately privileging urban performance or the social reactivation of heritage. Within this framework, the comparison between the two analysed models assumes a foundational role in the construction of the proposed method: their strengths and weaknesses have been translated into operational dimensions and subsequently integrated into the panel of indicators, defined based on the analysed documentation. The contribution therefore proposes an interpretation of stations as a distributed territorial infrastructure, translating theoretical references on proximity, multimodality, and governance into a multi-criteria tool applicable to the Italian context.

The Lombardy station system as a territorial infrastructure

In recent years, the Lombardy Region has launched initiatives to enhance the railway station system, strengthening its role as recognisable nodes, functionally integrated within sustainable mobility and urban regeneration policies. The scale of railway infrastructure across the regional territory is significant: the network extends for approximately 2,000 km and includes 464 stations, of which 125 (some inactive) are under direct regional management and entrusted under concession to Ferrovie Nord (FN), while the remaining

stations are managed by Rete Ferroviaria Italiana (RFI) and Ferrovie Emilia-Romagna (FER). In 2023, the Lombardy Region promoted a study on the development and enhancement of the railway station system and the design of operational tools (SINLOC, 2023), aimed at identifying operational models and replicable tools for the refunctionalisation of the existing heritage, with particular attention to the growing number of unattended stations². The study recognises a new public-interest vocation for stations, to be implemented through the involvement of municipal administrations and the activation of new services and proximity functions, especially in less-served areas. The approach prioritises adaptive reuse strategies that are lightweight and reversible, oriented towards the conservation of existing heritage and environmental and social sustainability.

Within this framework, the network managed by FN³ represents a significant portion of the overall Lombardy railway system, dating back to the late nineteenth century and branching into the so-called Milano Branch and Iseo Branch. The Strategic Plan of Ferrovie Nord Milano 2024-2029 (FNM, 2024a) identifies the railway network as a central infrastructural asset, envisaging investments in upgrading and modernisation aimed at improving safety, efficiency, service quality, and environmental sustainability, also from a sustainable-mobility perspective. In this context, the network is con-

Macro-area	Criterion	No. of indicators	No. of indicators satisfied	% indicators satisfied	Outcome
A. Multimodality and accessibility	A1	6	5	83.33%	HIGH
	A2	5	0	0%	LOW
	A3	3	1	33.33%	LOW
				38.89%	MEDIUM
B. Functionality and proximity	B1	5	4	80%	HIGH
	B2	4	1	25%	LOW
	B3	3	3	100%	HIGH
				68.33%	HIGH
C. Environmental and social sustainability	C1	5	0	0%	LOW
	C2	3	1	33.33%	LOW
	C3	6	2	33.33%	LOW
				22.22%	LOW
D. Spatial quality	D1	4	0	0%	LOW
	D2	4	2	50%	MEDIUM
	D3	3	2	66.67%	MEDIUM
				38.89%	MEDIUM
E. Safety and surveillance	E1	4	2	50%	MEDIUM
	E2	4	3	75%	HIGH
				62.50%	MEDIUM

Tab. 3 | Summary table of the results of the checklist for Milano Cadorna Station (credit: the Authors, 2026).

Type of analysis	Responsible party	Objective of the analysis	Output	Impact on decisions
Analysis of the area's historical and architectural characteristics	Politecnico di Milano	Representation of the historical stratification and specific characteristics of the buildings	Evidence of portions dating back to the 1940s	Operational guidelines consistent with historical elements from different periods and with the stratification of the buildings
Analysis of the area's management characteristics	Politecnico di Milano + Ferrovie Nord	Representation of the organisational processes of station spaces and related performance indicators	Reconstruction of existing management models and identification of inefficiencies and critical issues in the use of space	Support for the rationalisation of spaces, the redefinition of functions, and the optimisation of services
Analysis of mobility flows and intermodality	Specialist consultant	Evaluation of origin-destination movements of people and/or vehicles, with a description of volumes, directions, and temporal variables	Identification of traffic congestion points, the need to implement mobility services, and improvement scenarios	Definition of interventions for flow management, improved accessibility, and enhanced mobility services
Static and seismic assessment	Specialist consultant	Evaluation of structural safety under design seismic loads	Non-compliance with current regulations	Need for seismic upgrading in the event of interventions on the passenger building
Structural analysis	Specialist consultant	Structural behaviour of the building under gravitational forces and operating loads	Static equilibrium in the absence of interventions; critical issues in the event of structural modifications and partial demolitions	Definition of design alternatives compatible with any structural interventions
Archaeological analysis	Specialist consultant	Reconstruction of the archaeological potential in the area	Absence of significant archaeological evidence	No direct impact on decisions
Geophysical and geognostic analyses	Specialist consultant	Representation of the stratigraphic and geotechnical composition of the subsoil	Absence of significant geotechnical criticalities	No direct impact on decisions
Topographic survey	Specialist consultant	Representation of the current state of the structures and their geometric configuration	Survey of site conditions and digital cartographic bases	Knowledge base for subsequent design and construction phases

Tab. 4 | Matrix of sub-areas, critical issues, and actions for the areas of Milano Cadorna station (credit: the Authors, 2026).

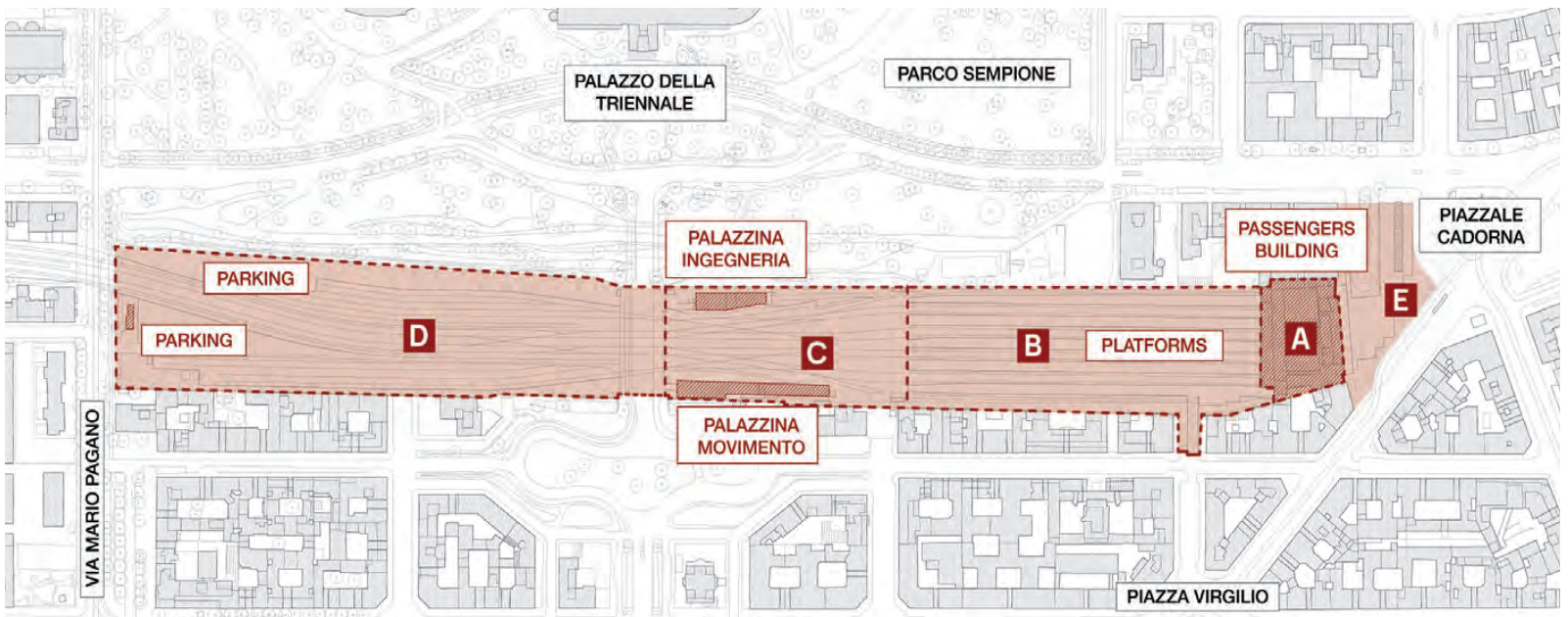


Fig. 12 | Reference sub-areas of Milano Cadorna station (credit: the Authors, 2026).

ceived as the backbone of an integrated regional mobility system, whose sustainability has recently been addressed in the Sustainability Report (Trenord, 2024), which aims to improve environmental quality and circularity at stations and in railway services.

Among the priority interventions is the FILI project, an integrated transformation programme along the Milano-Malpensa axis that involves the main nodes of the network (Milano Cadorna, Bovisa, Saronno, and Busto Arsizio) and their surrounding areas. The project operates at the scale

of an infrastructural corridor, structuring actions across three levels: the regeneration of railway nodes, the development of the Milano-Malpensa cycle superhighway (54 km), and environmental interventions, including reforestation along the corridor. FILI interprets the railway network as a territorial backbone, integrating rail mobility, soft mobility, and ecological continuity, thereby reinforcing the railway's interpretation as an integrated urban and territorial infrastructure (FNM, 2024b).

Overall, the initiatives promoted by the Lombardy Region and the companies of the Ferrovie

Nord Milano Group outline a development strategy that recognises the railway network and its stations as structural elements for regional accessibility, ecological transition, and territorial equity. The institutional interest in coordinated, multi-scalar, and replicable interventions confirms the centrality of stations as strategic territorial devices, opening the way for methodological tools that can systematically support these transformation processes.

A systemic method for the regeneration of stations as proximity infrastructures | Within this

A | PASSENGER BUILDING

Macro-area	Criterion	Critical issues identified by the checklist	Operational guidelines	Priority level (1-3)
A. Multimodality and accessibility	A1	Poor provision of cycling services and infrastructure	Increase cycling services and strengthen connections to the urban network	3
	A2	The station lacks tactile pathways for visually impaired users, differentiated access routes to the platforms for different types of users, and an adequate access control system, resulting in congestion in the concourse at certain times	Install LOGES tactile routes, diversify access, and upgrade the control system	3
B. Functionality and proximity	B1	There are no waiting areas for travellers inside the building	Create waiting areas that meet current standards	3
	B2	There are no spaces dedicated to cultural, social, or local development services	Include civic services and spaces for cultural and social activities	2
C. Environmental and social sustainability	C1	The facility's environmental performance does not include the production or use of energy from renewable sources, rainwater management, or the adoption of microclimatic mitigation techniques	Integrate energy systems and solutions for water management and environmental mitigation	3
	C2	The station does not feature low-impact design solutions or environmental certifications	Introduce sustainable, low-impact design solutions	2
	C3	There are no participatory co-design processes in place, no spaces dedicated to meeting and development initiatives, and no help desks for vulnerable groups	Activate co-design processes and include spaces for social purposes and support for vulnerable groups	2
D. Spatial quality	D1	The maintenance condition shows widespread visual deterioration, with obsolete materials and deteriorated finishes, along with underutilised spaces. The building requires seismic and structural upgrading	Refurbish materials and spaces, and plan structural adaptations	3
	D2	The waiting areas are inadequately sized and lack the necessary equipment, and the signage is confusing	Improve waiting areas and reorganise information systems	3
	D3	The covered access area to the station and the square in front are in a dilapidated condition	Redevelop the public space of the square and improve urban quality	3
E. Safety and surveillance	E1	The concourse has numerous blind spots, especially in the mezzanine and in the spaces created by the central volumes	Eliminate blind and underused areas resulting from the central volumes and the mezzanine	3
	E2	Safety signage is undersized and inadequately marked	Integrate and improve safety signage	3

B | PLATFORMS

Macro-area	Criterion	Critical issues identified	Operational guidelines	Priority level (1-3)
A. Multimodality and accessibility	A2	Accessibility is incomplete because the platform height does not meet the standards of trains in circulation, and because tactile pathways for visually impaired users are absent	Install LOGES tactile pathways for visually impaired users, and adjust platform height to the entrance height of trains in circulation	3
	A3	The existing underpass does not connect the tracks to the surrounding areas outside the station area and is closed to passenger traffic	Assess the opening and integration of the underpass into the city	1
B. Functionality and proximity	B1	The platforms do not have seating for waiting passengers	Install adequate seating for waiting passengers	2
C. Environmental and social sustainability	C1	The canopies do not provide energy production from renewable sources or rainwater management	Assess the installation of solar panels on the canopies and the integration of a rainwater recycling system	3
	C2	The canopies and platforms do not include low-impact environmental design solutions	Develop low-impact design solutions	2
D. Spatial quality	D1	The platforms and canopies are clearly in disrepair, with deteriorated and obsolete materials and finishes	Refurbish or replace the canopies	3
E. Safety and surveillance	E1	Canopy lighting is inadequate	Integrate adaptive lighting systems	3
	E2	Safety signage is undersized and inadequately signposted	Improve signage	3

Tab. 5a, 5b | Operational guidelines and priority actions for the regeneration of the sub-areas of Milano Cadorna station, defined in relation to the multi-criteria assessment and the positioning matrix. Priority level: 1 = high; 2 = medium; 3 = low (credit: the Authors, 2026).

framework, the research proposes an operational method to guide the transformation of railway station areas managed by Ferrovie Nord and their surrounding spaces as nodes of a renewed, capillary infrastructure of proximity and territorial equity. The station is therefore understood not only as a technical artefact, but as a component of an intelligent and sustainable territorial mobility infrastructure, in continuity with approaches that interpret urban connections as integrated systems of transport, public space, and sustainability (Bruno et alii,

2024). The method is structured into three integrated phases: analytical-cognitive, strategic-programmatic, and application-oriented. The first analytical-cognitive phase consists of systematically mapping the railway heritage of the Lombardy lines managed by Ferrovie Nord. The analysis aims to collect data on the architectural and infrastructural typologies of stations⁴, passenger flows, the functional ranking system used by the operator⁵, and the condition of the built assets (refurbished or requiring refurbishment), in order to produce, through

mapping, a structured knowledge framework at the network scale. At the same time, underused or residual spaces within station buildings and adjacent structures are catalogued in order to identify potential areas for activation. The outcome of this phase is the construction of a territorial and typological database that supports a comparative and multi-scalar interpretation of stations (Fig. 1-3). The second strategic-programmatic phase develops a multi-criteria analysis and evaluation tool, which constitutes the operational core of the me-

thod. This methodological framework aligns with approaches to urban strategic foresight that operate across multiple scales, guiding scenarios and intervention priorities rather than isolated projects (Mantziaras, 2024).

The multi-scalar tool integrates urban, infrastructural, architectural, managerial, and social dimensions and comprises four elements to be assessed in an integrated manner:

1) Pre-evaluation with positioning, which incorporates classifications developed during the mapping phase and integrates them with the territorial context (urban, peri-urban, extra-urban); the pre-evaluation calibrates the application of the checklist according to the station profile and defines the required level of detail;

2) Multi-criteria checklist, structured into five macro-areas (accessibility and multimodality; functionality and proximity; environmental and social sustainability; spatial quality; safety and surveillance), each articulated into specific criteria, representing the main qualitative evaluation tool; the macro-

areas, criteria, and indicators derive from a systematic review of scientific literature on station regeneration processes, as well as from the analysis of institutional, international and national documents and operational frameworks⁶; the indicators were validated through dialogue with infrastructure managers and territorial stakeholders; the checklist can be applied uniformly across all stations in the network, and the level of indicator fulfilment is assessed qualitatively as high, medium, or low⁷;

3) Targeted technical-specialist analyses, activated selectively in support of the checklist, including surveys of the existing condition, constraint analysis, analysis of historical and architectural characteristics, flow analysis, and management-related analyses, as well as further technical investigations where necessary;

4) Multi-level participatory tools, integrated into the evaluation phase and articulated across two levels; the first level involves governance-related participation tools such as interviews, focus groups,

and working tables with local and supra-local stakeholders, aimed at fostering dialogue and developing shared policies; the second level directly involves station users and the wider population through questionnaires and co-design workshops⁸; the outcomes of these participatory processes inform the definition of needs and the identification of priorities.

The outcome of the second phase is a profile structured by macro-areas, providing a qualitative evaluation that highlights critical issues, consolidated aspects, and potential areas for activation. The third application-oriented phase consists of applying the tool to the selected station areas. The results of the strategic-programmatic phase are synthesised into a concise station profile, enabling the prioritisation of interventions according to the station's role within the network, its territorial context, and the condition of its built assets. Based on this interpretation, operational guidelines and transformation scenarios are defined in coherence with the node's configuration. The method

C | 'PALAZZINE'

Macro-area	Criterion	Critical issues identified	Operational guidelines	Priority level (1-3)
A. Multimodality and accessibility	A2	The presence of numerous architectural barriers prevents universal accessibility	Eliminate architectural barriers	3
	A3	Numerous physical barriers impede integrated circulation between buildings, surrounding areas, car parks, and the station	Improve connectivity between the different parts of the facility	1
C. Environmental and social sustainability	C1	There are no solutions for reducing high levels of noise pollution or mitigating hazards in outdoor spaces	Integrate noise and environmental mitigation systems	3
	C2	The buildings do not feature low-impact design solutions or environmental certifications	Introduce low-impact environmental strategies	2
	C3	There are no dedicated spaces for workers to encourage meeting and socialising during working hours	Include spaces for employee conviviality and well-being	2
D. Spatial quality	D1	The maintenance condition shows widespread visual deterioration, with obsolete materials and deteriorated finishes, along with inadequate spaces	Refurbish and reorganise spaces	3
	D2			
	D3	The surrounding outdoor spaces are deteriorated and underutilised	Improve the quality and use of outdoor spaces	2
E. Safety and surveillance	E1	The presence of blind spots at the rear of buildings reduces perceived safety	Eliminate or redevelop uncontrolled spaces	2

D | PARKING AREA

Macro-area	Criterion	Critical issues identified	Operational guidelines	Priority level (1-3)
A. Multimodality and accessibility	A2	The parking areas are not accessible to people with reduced mobility, and the parking-station connection is not universally accessible	Create accessible pedestrian routes	3
	A3	Urban continuity is interrupted, and there are no access or permeability elements outside the car park entrances	Improve urban connectivity and permeability, and introduce new pedestrian routes	1
C. Environmental and social sustainability	C1	The surfaces of these areas are completely impermeable and contribute to heat-island effects; solutions aimed at reducing high levels of noise pollution and hazards in these areas are inadequate and obsolete; climate mitigation solutions are lacking	Integrate solutions for microclimatic and acoustic mitigation	3
	C2	These areas do not include design solutions or low-impact materials; there is an open-air waste collection point	Introduce sustainable materials and sustainable waste management systems	2
D. Spatial quality	D1	The maintenance condition shows significant visual deterioration	Renovate the spaces	2
	D3	There are dilapidated temporary structures in the underpass	Remove incongruous elements	2
E. Safety and surveillance	E1	Lighting is insufficient and obsolete, and does not ensure an adequate level of perceived safety	Improve lighting systems	3

Tab. 5c, 5d | Operational guidelines and priority actions for the regeneration of the sub-areas of Milano Cadorna station, defined in relation to the multi-criteria assessment and the positioning matrix. Priority level: 1 = high; 2 = medium; 3 = low (credit: the Authors, 2026).

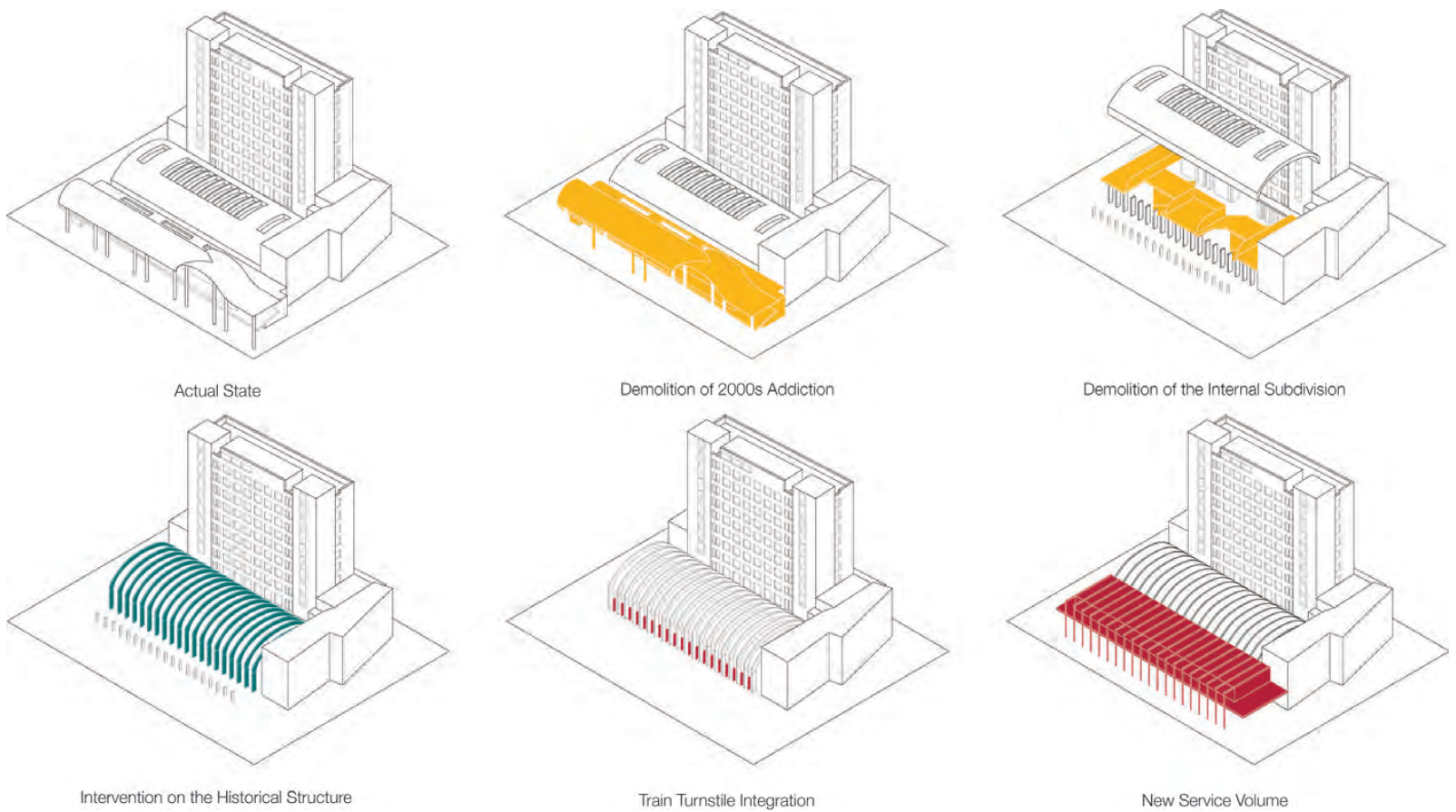


Fig. 13 | Diagrams of possible actions for spatial reorganisation of the passenger building (credit: the Authors, 2026).

thus enables the transition from analytical knowledge of the railway heritage to a selective programming of interventions, ensuring comparability at the network scale and adaptability to individual cases. Although applied to the Lombardy network of Ferrovie Nord, it is transferable to similar contexts: in particular, the three-phase structure, the evaluation of macro-areas, and the integration of analysis, participation, and operational guidelines are transferable, while certain classification tools (ranking systems and internal manuals), and proprietary data remain specific to the Ferrovie Nord context and can be replaced by equivalent systems elsewhere.

Milano Cadorna: a case application | Milano Cadorna station is one of the historical and strategic nodes of the Lombardy railway system. Located in the heart of the Milan urban system, it plays a primary intermodal role, integrating the railway lines of the Milano Branch of Ferrovie Nord, two metro lines, surface public transport, and numerous urban cycling and pedestrian routes. Its historical stratification, consisting of an initial nineteenth-century structure and subsequent transformations carried out during and after the war period, is still legible today in the non-homogeneous architectural features of the complex (Fig. 4). The interventions initiated in the 2000s, including the façade redesign of the building by Gae Aulenti and internal adaptations of the station (Fig. 5), have redefined the contemporary image of the station area. However, critical issues remain concerning spatial quality, flow management, and technological and regulatory upgrading (Cornolò, 2006). Furthermore, there is a need to align the urban regeneration of

the entire area with the objectives of the Strategic Plan of the Ferrovie Nord Milano Group (FNM), particularly regarding quality and environmental sustainability (Figg. 6-8). The presented multi-criteria tool was applied to the Cadorna station area.

The pre-evaluation phase classified Cadorna as a modern station, with a platinum ranking and within an urban territorial context. The number of daily passengers amounts to 65,490. The results were based on the indicators and evidence presented in Table 2.

From the perspective of accessibility and intermodality, the station shows a high level of modal integration. However, several critical issues persist in terms of wayfinding and flow management: numerous level differences limit universal accessibility between the metro, the main hall, and platforms, as well as between platforms and trains (Fig. 9). In the macro-area of functionality and proximity, there is a good provision of commercial services and mobility-related facilities, contrasted by a limited presence of civic functions and non-commercial proximity spaces, which would be significant in relation to the reference context (Fig. 10). At the same time, the presence of unused or degraded spaces reveals considerable potential for activation. In terms of environmental and social sustainability, the analysis highlighted significant margins for improvement in external areas, particularly due to extensive impermeable surfaces and poor microclimatic quality (Fig. 11).

The macro-area of spatial quality revealed major critical issues in the passenger building facing Piazzale Cadorna (degraded or underused spaces, perceived congestion, poor organisation of signage, and limited integration of audio-visual

systems) and on the platforms (material degradation, and the need for regulatory upgrading). Within the station area, additional railway and office buildings (Palazzina Movimento and Palazzina Ingegneria) are present, whose maintenance condition and proximity to the tracks, particularly the Palazzina Movimento, negatively affect the urban quality of the area. Regarding safety, although the station is almost constantly monitored, critical issues persist in the areas surrounding the square (Tab. 3).

In line with the methodological framework, the profile derived from the checklist was further refined through targeted technical-specialist analyses, triggered by the site's complexity and historical stratification. Given the nature of the case study, the overall evaluation was supported by analyses concerning transport systems, structural conditions, statistical data, and geophysical aspects, aimed at verifying the condition of the existing buildings and the feasibility of potential interventions (Tab. 4).

The participatory phase was structured through institutional working groups involving the various companies of the FNM Group operating within the station and the Lombardy Region, as well as through structured meetings and focus groups. In particular, the working groups were organised by thematic areas and decision-making levels: regional working groups aimed at defining the overall needs framework; technical working groups for analysing the condition of buildings and infrastructure; and meetings with representatives of different departments of the Group (sustainability, functionality, and railway service) to identify specific critical issues and opportunities. This process contributed to the definition of a shared needs frame-

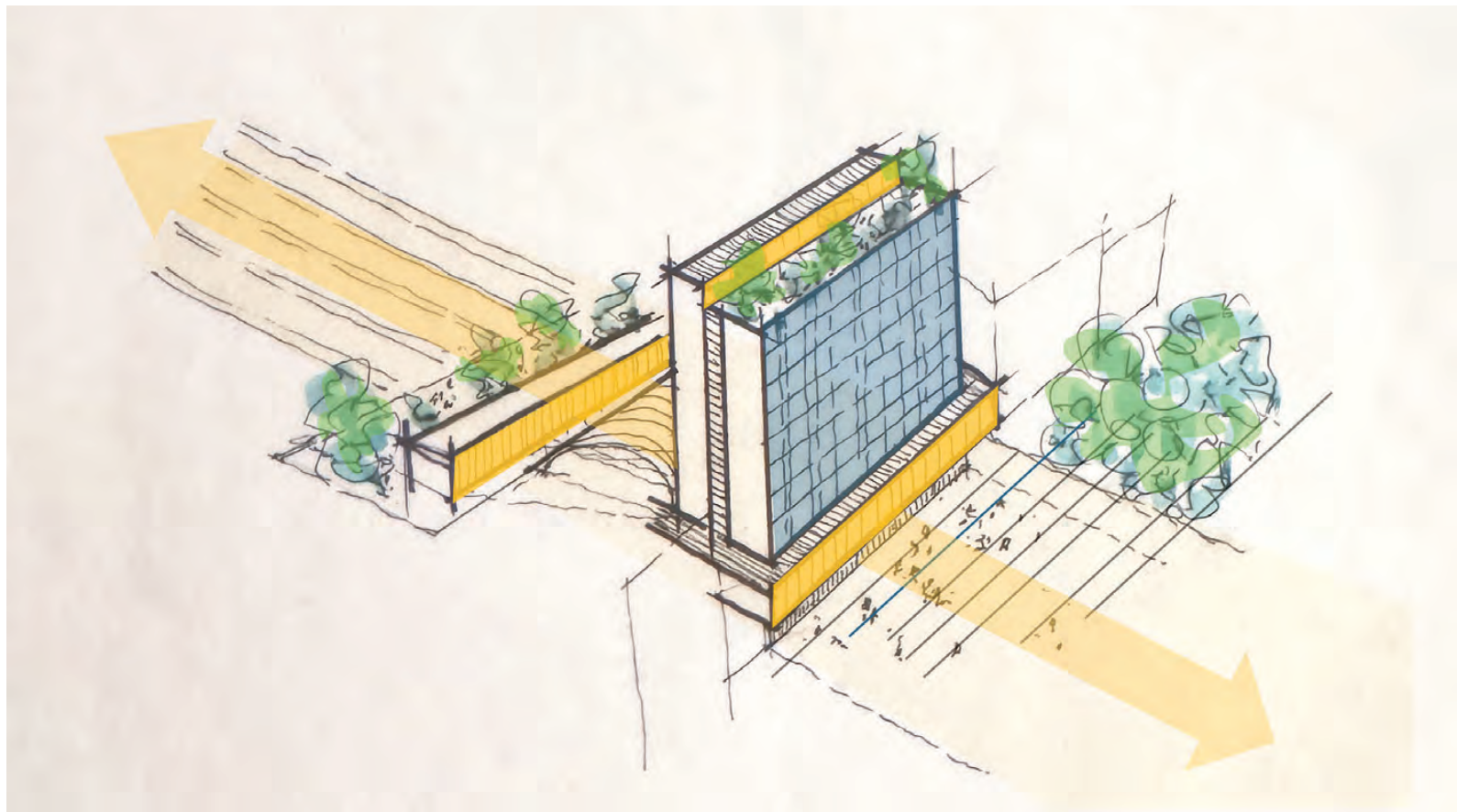


Fig. 14 | Vision sketch of the area (credit: M. P. Vettori, 2026).

work, primarily focused on strengthening multi-modality, improving public spaces, and enhancing environmental quality in the station area. Discussions with infrastructure managers highlighted specific spatial and functional needs, configuring Cadorna as a unique case of hybridisation between railway and workplace environments, characterised by a close physical and managerial interrelation. A questionnaire was also prepared for users and for the population frequenting the station area to identify patterns of use and emerging needs.⁸

Finally, the outcomes of the checklist and the technical analyses, based on verifiable evidence, were translated into operational guidelines and intervention priorities. Given the complexity and size of the area (approximately 58,000 m²), homogeneous sub-areas were identified according to their characteristics and typologies (Fig. 12). For each of these, specific guidelines and priority actions were defined, based on the correlation between the levels identified in the macro-areas and the positioning matrix defined during the pre-evaluation phase (Tab. 5).

For the Passenger Building (Area A – 4,545 m²), the identified critical issues suggest a functional and spatial reorganisation of the main hall and internal spaces to improve access, flow management, waiting areas, and the reuse of under-utilised spaces. Interventions on building volumes and the vaulted roof must be assessed in relation to structural verifications and heritage constraints, integrating conservation requirements with functional upgrading. For the Platform Area (Area B – 14,670 m²), the analysis indicates the need for interventions to ensure universal accessibility to trains

and platforms, improve environmental performance, and renew paving and canopies, in coherence with the overall identity of the station.

For the Palazzina Area (Area C – 8,170 m²), the guidelines suggest improving usability and connections with the passenger building, as well as a comprehensive refurbishment of the office buildings (Palazzina Movimento and Palazzina Ingegneria) and their external spaces to enhance urban and environmental quality. For the Parking area (Area D – 20,810 m²), sustainability-related issues indicate the need to improve pedestrian accessibility, enhance environmental quality, mitigate microclimatic and acoustic conditions, and reorganise surfaces currently used for surface parking.

Beyond interventions in individual sub-areas, the need emerged to strengthen the systemic relationship between the station and the city, particularly by enhancing cycling mobility, multimodal interchange, and the quality of surrounding public spaces (Area E). These actions would extend regeneration beyond the railway boundary, configuring Cadorna as an integrated urban infrastructure capable of contributing to widespread accessibility and public space quality from a territorial equity perspective.

As a complement to the analysis, some possible spatial interpretations of the identified guidelines were developed. These do not constitute validation of the method itself but represent a possible design vision of the proposed strategies, applied to specific elements of the station area (Fig. 13, 14).

Discussion: synergies, trade-offs, transferability | The contribution highlights how the regeneration of railway station areas requires structured

synergies between infrastructure asset owners, public administrations, local authorities, private investors, and local communities. The hybrid nature of the station – both a technical node and a public space – implies the need to reconcile different and not always convergent demands, including asset valorisation, infrastructural upgrading, economic sustainability, and proximity-based functions.

The application of the multi-criteria method has shown that these synergies inevitably generate trade-offs: increasing multimodality entails complex spatial reconfigurations; introducing new proximity functions may conflict with real estate valorisation models; and preserving historical heritage may limit interventions aimed at energy efficiency or volumetric expansion. The macro-area-based approach makes these dynamics explicit and supports informed programmatic decisions at the network scale, integrating infrastructural innovation with attention to territorial cohesion. This perspective aligns with urban strategic foresight approaches that, at the European scale, emphasise the construction of shared visions and long-term scenarios for infrastructure and territories (Mantziaras, 2024). The limitations of the study are related to the varying levels of operational maturity among the analysed stations: while some nodes already have active programmes, many stations are still at the stage of strategic vision, making the method verifiable primarily in terms of programmatic orientation rather than through ex post monitoring of outcomes. At present, the method has been applied only to the Cadorna case, but validation is ongoing for stations in the Milan hinterland along the Milano-Saronno line. Further critical issues concern the availability and homogeneity of data, which are

not always guaranteed in less structured contexts, as well as the choice to prioritise a qualitative multi-criteria evaluation, which enhances applicability and adaptability but does not allow for standardised quantitative measurement of impacts.

The dissemination of a systemic approach to station regeneration also encounters cultural, economic, and institutional barriers. A perception of the station as a purely technical infrastructure persists, while fragmented ownership and rigid concession models may hinder integrated interventions. Regulatory complexity and heritage constraints require stable and coordinated forms of multi-level governance. Within this context, the proposed method can be understood as an adaptable tool for regional railway networks characterised by distributed assets and similar concession structures, thanks to its modular articulation – mapping, checklist, targeted analyses, and participation – which ensures comparability at the network scale and flexibility across different contexts.

In relation to the Sustainable Development Goals, the proposed methodological approach directly contributes to strengthening resilient infrastructure (SDG 9), reducing territorial inequalities (SDG 10), enhancing urban quality and sustainable regeneration (SDG 11), and mitigating environmental impacts (SDG 13). These contributions are accompanied by indirect effects on other areas, particularly urban well-being (SDG 3), equitable access to services and opportunities (SDG 1), the quality of public spaces and living environments (SDG 16), and the strengthening of cooperation

between public and private actors (SDG 17), generating synergies between mobility, public space, and social inclusion. At the same time, the methodological approach highlights potential trade-offs among economic efficiency, heritage protection, and environmental objectives, and their management requires appropriate levels of governance, data availability, and coordination among stakeholders.

Conclusions | The research contributes to the debate on the regeneration of railway stations by proposing their interpretation as territorial infrastructures of proximity, capable of integrating the infrastructural dimension, spatial quality, services, and social inclusion at the network scale. In particular, the contribution introduces a multi-criteria method that translates into operational terms the main dimensions emerging from recent literature on the regeneration of station areas – intermodality, proximity, sustainability, and governance – overcoming sectoral approaches and proposing a comparative structure applicable to heterogeneous contexts.

In a European and Italian context characterised by the widespread presence of stations requiring infrastructural, functional, and environmental upgrading, the presented methodological approach enables a transition from a descriptive reading of critical issues to their prioritisation and operationalisation, supporting more informed decision-making in the programming of interventions. In this sense, the contribution is configured not

only as an analytical tool, but also as a support device for strategic planning, capable of connecting infrastructural and urban dimensions.

From the perspective of transferability, the method can be applied to railway networks characterised by distributed assets and different governance conditions, thanks to its modular and adaptable structure. Its application, however, requires certain basic conditions, such as the availability of minimum data, the presence of classification systems, and collaboration among infrastructure managers, local administrations, and territorial actors.

From a research agenda perspective, the study opens up further developments, particularly in the integration of qualitative and quantitative indicators in the analysis and evaluation of existing assets; in the exploration of multi-level governance models for managing urban and railway regeneration processes; in the definition of ex post monitoring systems for social and environmental impacts; and in the further development of methods and processes for the adaptive reuse and transformation of railway spaces and heritage. Within this perspective, railway stations can be understood as central devices for the ecological and social transition of contemporary cities, contributing to guiding policies towards more equitable mobility systems, more inclusive public spaces, and greater territorial cohesion.

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The paper is the result of a shared reflection by the Authors. Nevertheless, the introductory section is attributed to M. P. Vettori; 'Comparative international experiences in station regeneration' to A. Dechamps; 'The Lombardy station system as a territorial infrastructure' and 'A systemic method for station regeneration as proximity infrastructures' to F. Daprà; 'Milano Cadorna: a case application' to S. Battaglia; and the concluding section to all the Authors.

Notes

1) The document 'Het Stationsconcept' contains the overall guidelines concerning the role and conception of stations. There are also numerous documents addressing

specific themes that function as policy manuals for station regeneration or design, covering topics ranging from lighting to circularity, from landscape impacts to the regeneration of areas surrounding stations. For more information, see: spoorbeeld.nl/beleid [Accessed 2 April 2026].

2) Out of a total sample of 348 stations in the Lombardy network (excluding provincial capitals, already regenerated stations, and inactive ones), in 2023, 197 stations were unattended, corresponding to 56% of the total, of which 115 were managed by Rete Ferroviaria Italiana and 82 by Ferrovie Nord (SINLOC, 2023).

3) Ferrovie Nord is part of the Ferrovie Nord Milano Group, through which the Lombardy Region directly intervenes in the management and upgrading of infrastructure, and through Trenord (another company of the FNM Group), coordinates – together with Trenitalia – the regional railway service operating on a large-scale system covering almost all municipalities in Lombardy.

4) The classification of stations by typology was developed in a previous research project, which distinguished between historical stations and modern stations, as well as additional categories based on the specific characteristics of passenger buildings. This classification, currently in use, is defined in the Station Interior Spaces Manual ('Definizione delle linee guida per le scelte stilistiche, dei materiali e finiture degli spazi del gruppo FNM e per la specializzazione dei criteri utili alla definizione dei requisiti quali-quantitativi degli spazi ufficio', research contract under Article 2.4 of the Framework Agreement for Scientific Collaboration signed on 02/02/2021 no. 4600008166 between Ferrovie Nord S.p.A. and Politecnico di Milano; Scientific Coordinator: M. P. Vettori).

5) The station ranking system, established in an official Ferrovie Nord document, classifies stations based on five

weighted parameters: passenger flow, stopping trains, typology, services, and relevance. The categories are defined as follows: platinum (9 stations), gold (19 stations), silver (22 stations), bronze (41 stations), and white (24 stations). The complete classification is outlined in the document 'Station Ranking for the Milano and Iseo Network' (internal Ferrovie Nord document, 2022).

6) The panel of indicators was constructed, according to the five macro-areas, based on national and international documents, consulted literature, and previous research conducted by the authors on multi-criteria tools for analysing built heritage; some indicators were directly provided by infrastructure managers. In particular, for mobility and passenger services, indicators from international documents such as UIC (2020, 2023) and ARUP (2019, 2022) were considered. For building quality, station functionality, and sustainability, refer to SINLOC (2023) and Trenord (2024).

7) The evaluation is based on the percentage of indicators satisfied relative to the total number of indicators for each criterion. Specifically, the evaluation level is defined as 'high' when more than 67% of indicators are satisfied, 'medium' when from 36% to 63% are satisfied, and 'low' when fewer than 33% or below are satisfied.

8) The first phase of governance-level participation has been completed, and some questions have been included in Trenord's customer satisfaction survey; the extended questionnaire for users is currently under validation and will be administered in the coming months.

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