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Abstract

Within transport systems, train stations cover a primary role as places where access to different modes of transport must be realised effectively, providing a valuable opportunity to make rail services, public transport, and soft mobility more attractive. This research seeks to shed some light on how Italian travellers perceive the quality of train stations, and to identify priorities for action in relation to design, building, and operation that might help revitalise their attractiveness. The methodology involved designing a questionnaire capable of identifying significant correlations between attitudinal and behavioural variables via an exploratory factor analysis, reaching around 400 respondents through a snowball sampling plan. The factor "sociality and daily life" showed the importance that people place on the vitality of urban places. Travellers also consider other factors, like the overall service quality, the cleanliness and safety of a train station, the walkability of connections within the node, and the possibility of reaching the station by bicycle. The profiling of respondents using a cluster analysis based on latent factors points to specific policies, showing how actions targeting stations can have positive effects on the use of rail transport and on the propensity towards intermodality and sustainable mobility. A safe, "living" place can mitigate the risk of social degradation, while promoting walking and cycling.

Keywords: transit-oriented development; train stations; railway stations; travel behaviour; surveys; sustainable mobility; case study

Academic Editors: Jinhao Liang, Chaopeng Tan, Jiwei Feng and Jian Wu

Received: 8 July 2025
Revised: 22 August 2025
Accepted: 29 August 2025
Published: 31 August 2025

Citation: Pronello, C.; Torre, F.; Boggio Marzet, A. Make Train Stations More Respondent to User Needs: An Italian Case Study. *Sustainability* **2025**, *17*, 7838. https://doi.org/10.3390/su17177838

1. Introduction

The transport sector is currently accounting for about a quarter of Europe's greenhouse gas emissions [1], and there is an awareness that the mobility of people needs a fundamental rethink. Almost all environmentally and socially sustainable alternatives to the private car for door-to-door travel involve some sort of intermodality [2], and a major consideration inciting people to abandon their cars in favour of other modes is accessibility.

Interchange nodes—and in particular train stations—therefore have a strategic role to play in providing access to different modes of transport. At the same time, train stations are also a central part of the urban heritage. They are attractive poles, increasingly characterised by the presence of commercial and leisure services, and are often key elements in urban renewal plans and redevelopment projects. Over time, new uses emerge alongside their function as places of passage [3].

In Italy, the main rail infrastructure manager Rete Ferroviaria Italiana (RFI) is engaged in a programme of station improvement. This programme, Piano Stazioni (Stations Plan), lays down policy guidelines, drawing on GIS-based location intelligence tools analysing

transport, urban, economic and social data [4]. As regards the literature, research has examined a number of potential factors for station improvement: functionality, upkeep, mobility info and lighting, pedestrian accessibility [5]; safety and security [6]; energy efficiency, urban and architectural heritage [7]; creation of pedestrian areas and adequate spaces for interaction with cycling mobility [8]; appropriate use of green spaces; and inclusion of new services and spaces for people. All these factors affect people's perceptions and directly influence the attractiveness of journeys that encompass stations [9], particularly in regard to pedestrian accessibility [5] and perceptions of safety [10]. In discussions with local public institutions that establish guidelines for territorial and mobility development via Sustainable Urban Mobility Plans (SUMPs) and an urban planning strategy, these are consequently all factors that need to be considered.

The term "transit-oriented development" (TOD) is used in the literature to refer to spatial and urban planning that is centred around public transport services and interchanges [11]. Those services and interchanges are seen as "places where the accessibility provided becomes spatial capital" [12]. Since the late 1990s a number of studies have been performed, mainly with reference to North America, where there is often a poor match between population density and public transport provision [13]. However, the methods and findings of these studies may also have relevance in Europe [14], where various policy initiatives have sought to make commuter mobility more sustainable [15], and significant resources have in recent years been channelled into transport infrastructures and urban renewal plans [16]. The same kind of analysis will also be of interest to railway infrastructure managers seeking to make railway services more attractive. Improving the functionality of stations means analysing the characteristics of those stations in their geographic context [17] and adopting a strategic view on the location of transit nodes.

Urban and mobility planning can be improved by studying mutual dependencies in relation to a "land use-transport feedback cycle" [18], as shown in Figure 1, insofar as new infrastructures with a potential for changing people's utility functions can contribute to meeting social and environmental goals [19].

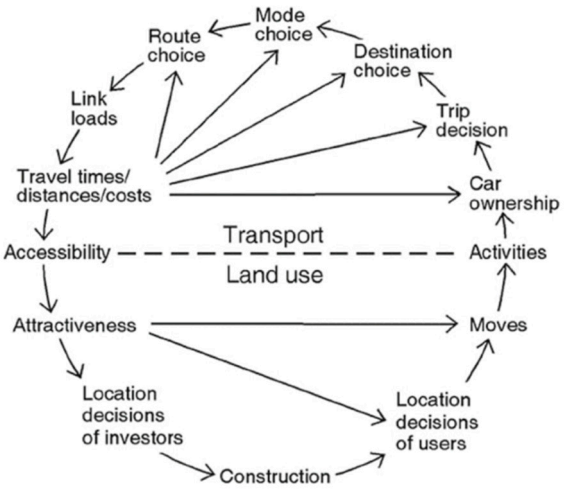


Figure 1. The land use-transport feedback cycle [18].

As the literature recognises [20], there are a variety of mechanisms (for example, public–private partnerships) that can help ensure the success of TOD policies. From a methodological perspective, the most popular analytical models to date are the "Node-Place model" [21], and the "TOD Index approach" [22].

The Node-Place model is based on two metrics that characterise transport nodes: a node value, corresponding to the potential supply of accessibility to the transport system,

and a place value, corresponding to the extent to which this potential is actually realised in terms of "human interaction and activities" [21]. The Node-Place model is able to represent the five scenarios depicted in Figure 2 and can provide insights into policy priorities: whether to focus on improving the transit system (unbalanced places), or instead to address the residential configuration (unbalanced nodes).

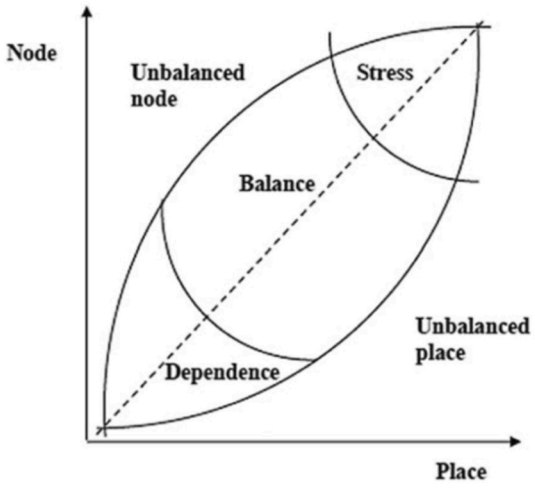


Figure 2. Node-Place model [21].

It is, in fact, unbalanced situations (unbalanced places or unbalanced nodes) that have a greater potential for improving accessibility, whether in the transit system or the urban heritage, so as to encourage walking and cycling, as also recognised by Eldeeb et al. [7].

The TOD Index approach [22], on the other hand, seeks to quantify the potential, sometimes referred to as the "TOD-ness" [23], of an area for transit-oriented development. TOD-ness is a multi-criteria measure that assigns specific weights to a variety of parameters (including, for example, urban heritage, residents' travel habits, local economy, and natural environment), giving an overall TOD index [12]. Residential density and current transport infrastructure might be expected to be the principal determinants of the TOD index, but Beria and Debernardi [24] found that the use of public transport, especially in large metropolitan areas, depends more on the location of hubs and their distances from where people begin their journeys. Destinations in areas of diffuse settlement still tend to generate significant flows of private vehicles, even where there are high or medium-high levels of infrastructure and public transport supply. Consequently, transit-oriented development needs to look further than simply raising density in built-up areas, and also examine the location of the poles of attraction [14], the presence of mass public transport lines, such as suburban railways or metro lines, and their accessibility in terms of first- and last-mile coverage.

Italy, while having a rather widespread settlement distribution across small and medium-sized urban centres, also has a very capillary railway network: 25% of Italians live and work within 1 km, and 50% within 3 km of a train station [4]. This represents a significant potential for shaping travel behaviour through careful land use [25] and cycling infrastructure development [8]. Given this potential, we believe it is important to look at how people perceive the quality of stations, with a view to identifying actions—in relation to planning, design, construction, and operation to help stations fulfil their role as new urban poles that encourage public transport use and first- and last-mile soft mobility. To this end, stations need to be attractive places, from both a functional and an aesthetic point of view [26]. As such, they offer an enormous opportunity for renewal and redevelopment of the urban heritage.

This research aims to support administrations and railway infrastructure managers in designing stations that drive territorial development through an experimental study covering a vast and geographically diverse area. Recent funding provided by the National Recovery and Resilience Plan for the Italian railway network includes stations as key hubs. Consequently, understanding how to transform stations into spaces that promote more sustainable mobility is becoming a necessity for administrations and infrastructure operators who manage them. This transformation cannot take place without focusing on users and their needs, but this requires in-depth knowledge not only of mobility needs, but also and above all of people's attitudes towards mobility and the places where it takes place. To this end, a questionnaire has been designed to capture people's attitudes and lifestyles in order to understand which variables matter and which interventions are necessary to invest in. The aim is to use an experimental approach to test, in addition to the variables already studied, psychosocial variables as well, in order to obtain a broader view of people's choices when travelling, seeking to overcome the limitations of the above-mentioned models, which are based mainly on transport supply and accessibility. We present our research as follows: Section 2 below is devoted to our methodology, covering survey design, questionnaire content, sampling plan, and data analysis design; Section 3 presents our results, relating to the socio-economic characteristics and mobility habits of respondents, their perception of train stations, and the elements potentially able to make stations more attractive, particularly with a view to encouraging travel intermodality and sustainable mobility; Section 4 discusses, in the light of our results, the policy outcomes (as regards the mobility ecosystem and the urban environment) towards which the transformation of train stations should be directed.

2. Materials and Methods

The extent to which train stations can and should be modified, and their architectural and functional layout redesigned, depends both on the needs of regular commuters and on the perceptions of travellers and users of stations more generally. Our research set out to investigate people's perceptions of train stations and the surrounding urban context, identifying elements that may favour their willingness to use railway services and intermodality. We report our research methodology as follows: (1) survey planning and design; (2) sampling plan and survey administration; and (3) data analysis design.

2.1. Survey Planning and Design

The relationship between stations and cities is changing, there being an increasing expectation that stations not only cater for regular commuters, but also fulfil a role as "new urban centralities" [27]. When seeking to stimulate more sustainable travel behaviour, it is important to take this expectation into account. For this reason, some questions were designed differently for habitual train users, occasional users, and those we called "never-takers", with respondents being invited to skip parts of the questionnaire that did not concern them. The questionnaire covers five sections:

- section 1 concerns the characteristics of trips (purpose, mode, including trip chain, frequency) undertaken in a "typical week" and asks respondents to designate the "most important trip";
- section 2 concerns the "most important trip" and includes detailed questions regarding the experience of users of commuter trains (whether regional, suburban/metropolitan, intercity, or high-speed), with reference to the stations they regularly use;
- section 3 concerns people's perceptions of train stations and surrounding areas, focusing not only on stations' transport function, but also on their role as urban poles of attraction;

- section 4 asks users to express preferences in relation to certain hypothetical scenarios, with a view to identifying how node characteristics may affect readiness to embrace intermodality when travelling. Independently of node performance and quality, respondents are also asked to indicate to what extent certain other properties of public transport services are important to them;
- section 5 collects socio-economic data from respondents: gender, age, educational qualifications, occupation, whether disabled or with reduced mobility, place of residence, household composition, car ownership, net monthly income range. Table 1 reports the main variables used for sections 2, 3, and 4.

Table 1. List of the main variables for sections 2, 3, 4.

Variable Name	Variable Description	Range
Section 2a—Variables relating to the most important trip. Read "relevance of:"		
TRVTIME	Modal choice: relevance of travel time	Likert scale from 1 (not relevant at all) to 6 (absolutely relevant)
TRVCOST	Modal choice: relevance of travel cost	
TRVCOMF	Modal choice: relevance of overall travel comfort	
TRIPCNTXT	Territorial context of door-to-door travel	Multiple choice
Section 2b—Variables relating to the most important trip for commuter train users		
DEPST_INFO	Departure station: there is clear and easily accessible information	Likert scale from 1 (totally disagree) to 6 (totally agree)
DEPST_WAY	Departure station: platforms are easily accessible on foot and are barrier-free	
DEPST_PARK	Departure station: there is convenient car park for those changing travel mode	
ARRST_INFO	Arrival station: it is easy to obtain information about complementary transport modes (metro, buses, trams, sharing services, taxis, etc.) from station boards and signs.	
ARRST_BUYTICKET	Arrival station: it is easy to buy tickets for complementary transport modes (metro, buses, trams, sharing services, taxis, etc.) from ticket offices, self-service vending machines, etc.	
ARRST_WAY	Arrival station: metro, taxi and bus stops are easily accessible on foot and are barrier-free	
STAT_URBQUAL	At both the departure and the arrival stations the urban landscape is pleasant and well maintained	
Section 3—Variables relating to people's perception of train stations and their surrounding areas (not linked to a specific journey)		
SECUR	The station that I use most frequently and its surrounding areas are, as I perceive them, safe places	Likert scale from 1 (totally disagree) to 6 (totally agree)
PULINT	The station's interior spaces are clean	
PULEST	The station's external spaces are clean	
TRAVSERV	Travel-related services are provided within the station (ticket offices, waiting rooms, etc.)	
RETSERV	Non-travel-related services are provided within the station (shops, restaurants, etc.)	
URBQUAL	I perceive the adjacent urban landscape as pleasant and well maintained	
PEDACC	The station is easily accessible for pedestrians	
BIKEACC	The station is easily accessible by bicycle	
PMRACC	The station is easily accessible for people with reduced mobility	
TPLINTERACT	I perceive that the interaction with other transport modes (public transport, sharing mobility, taxi, etc.) is effective	

Table 1. *Cont.*

Variable Name	Variable Description	Range
Section 4—Variables relating the quality of nodes as a determinant of to people's propensity to intermodality		
_REL	Respondents are asked to assign their personal level of relevance to the different attributes of stations that feature in section 3	Likert scale from 1 (not relevant at all) to 6 (absolutely relevant)
Relevance of the generic attributes of the public transport system:		
ACC_TPL	Accessibility of public transport services	
QUAL_TPL	Quality of public transport vehicles (comfort of seats, age of vehicles, cleanliness, etc.)	
TRVCOST_TPL	Total cost of public transport travel	
TRVCOMF_TPL	Comfort of travel, including the comfort of transfer, where applicable	
TRVEXP_TPL	Overall travel experience: possibility of engaging in other activities during the trip on at least one of the vehicles in the sequence	
Relevance of possible improvements to transport nodes:		
BIKEPARK_IN	Offering secure bicycle parking spaces	
URBQUAL_IN	Improving the urban quality of areas adjacent to the station (street furniture, green spaces, pedestrian areas, etc.)	
BIKEPATH_UP	Upgrading cycle paths connecting to the station	
WAYLINE_UP	Linearization and simplification of pedestrian paths connecting to the station	
WAYFNDNG_UP	Improving the station's wayfinding systems (vertical and horizontal signage)	
LIGHT_UP	Improving station lighting	
ELEV_UP	Improving elevators, escalators, etc.	
COWRKSPACE_IN	Offering coworking spaces inside the station	
RETAIL_IN	Offering commercial/retail services	

The questionnaire is based on a critical review of surveys found in the literature related to attitudinal aspects in mobility [28–30], on use of psychosocial variables in behavioural theories [31–45], and on previous questionnaires administered in Italy focused on attitudes and behavioural aspects [46–50].

2.2. Sampling Plan and Survey Administration

We adopted a snowball sampling plan, randomly selecting an initial group of respondents, who were asked to randomly designate other respondents belonging to the target population [51]. As a consequence, respondents were mainly students and employed people, with a prevalence of commuters and rail transport enthusiasts, meaning that the sample was not well representative of the overall population. This limitation will be addressed in our discussion of results, but we believe that the sample provides a good starting point in that it tends to reflect the perceptions of those who have some familiarity with train stations. Only 391 out of 901 respondents fully completed the questionnaire, and it is these 391 complete responses that were used to create our database. The survey took the form of a CAWI (Computer Assisted Web Interview) administered online between 30 May and 8 July 2022, via the Lime Survey web platform. The link to the questionnaire was disseminated via social media and the official websites of local transport companies (Gruppo Torinese Trasporti, Arriva, etc.) and Italian transport associations (ASSTRA, ANAV, and Legambiente). The respondents participated voluntarily, without any incentives or rewards.

2.3. Data Analysis Design

Ten of the completed questionnaires were considered to be inaccurate or inconsistent and were discarded, and therefore the final sample used for our analysis consists of 381 sets of observations. We performed three analyses using IBM SPSS Statistics 30.0 software:

- a descriptive statistical analysis, focusing on a "snapshot" of people's mobility habits, where we were also looking for statistically significant correlations between several selected variables;
- an ANOVA to compare train users and non-users with respect to variables related to accessibility, quality of the vehicles, travel cost, comfort and overall travel experience of public transport. ANOVA assesses whether the differences between the group means are statistically significant compared to the variability within the groups. When *p*-value is <0.05 significant differences exist between groups [52].an exploratory factor analysis (EFA) to identify the main "latent" factors that could explain respondents' preferences regarding the quality and functionality of train stations. EFA was used because we are still in the exploratory phase of the study and cannot rely on predefined models or hypotheses but need to obtain information from the data and discover hidden patterns among the variables. With reference to literature [53], the following assumptions were used: (i) commonality between the variables > 0.35; (ii) satisfaction of the Bartlett test (p-value < 0.05); (iii) Kaiser-Meyer-Olkin test with MSA > 0.5; (iv) extraction of factors with eigenvalue > 1, jointly used with scree test [54]; (v) loading factor > 0.4; (vi) cumulative explained variance > 60%; (vii) Cronbach's alpha method to test the analysis reliability;
- a cluster analysis on the latent factors to identify particular homogeneous groups of respondents as targets for transport interchange improvement policies. We used the non-hierarchical "k-means" clustering algorithm to better fit the continuous data obtained from the survey and to limit the statistical complexity through the application of the Euclidean distance of the variables from the mean (distance from the centroids). The individual score of each of the latent factors was calculated as a summated scale of that factor's variables. To verify the correctness of the number of clusters, we used two methods: first we carried out cluster analysis on the entire sample and then on two random subsamples (half of the total sample), testing different solutions from 4 to 6 clusters; solution remained stable on five clusters. Subsequently, given that our sample not very large, we used the Elbow method [55], which confirmed the optimal k value of five clusters.

3. Results

The descriptive statistical analysis identified the demographic, socio-economic and territorial characteristics of the sample, together with the characteristics of the most important trip, with a focus on habitual train users.

The sample is balanced in terms of gender. Among the age groups into which we divided respondents, the largest is 19–35 (48%), followed by 36–50 (28%), and then 51–60 (18%). There is a prevalence of people living in northern Italy (Piedmont and Lombardy regions), mainly in urban areas (69%) (Figure 3).

The level of education is medium-high, with over 82% of the respondents (315) having a high school diploma, among whom 59% (186—almost 49% of the total) also have obtained a bachelor's or master's degree. 47% of the respondents are employees and 22% are students. Just over half (53%) live in households of 1 or 2 persons, with the remainder living in households of 3 persons or more.

3.1. The Most Important Trip, Train Users and Perception of Nodes

Respondents mostly designated their most frequent trip during the week as "the most important", although for some respondents "the most important" trip was not necessarily a frequent one (for example, among those for whom the most important trip was one made for the purpose of "visiting relatives/friends in other cities/regions", 50% indicated a frequency of "less than once a week").

In suburban/rural areas the majority (55%) of trips are made by car, while intermodal trips account for only a small share (9%). Overall, 35% of the sample (134) habitually travel by train by, while 10% (40) use rail as an alternative or occasional mode of transport.

Trains are therefore used (either habitually or occasionally) by a total of 174 respondents, which represents 46% of the sample. The most common way of traveling to the station is by private car (31%), and the second most common is on foot (30%), followed by public transport (15%). Intermodality (more than one mode to access the station) accounts for around 10%, and "car-pooling" for a further 10%. Cycling accounts for only 3% of the modal share for the first mile, while shared mobility accounts for 2% of trips for the last mile, between the arrival station and the final destination.

Average times spent within departure and arrival stations, whether transferring to other transport systems or other types of services, are 28 min in the departure node and 22 min in the destination node. About half (52%) of people taking the train have to make a transfer to another mobility service, taking an average of 11 min. The most frequently used station services are self-service ticket machines (49% of respondents), the train company's staffed ticket offices (35% of respondents), and other non-travel-related commercial services (27% of respondents). Only 2% of respondents report the availability of coworking spaces within the station, while 40% of the sample see such spaces as "unavailable but desired". Train stations that form part of the most important trip score medium-low on most of the perceived quality indicators, the two exceptions being the accessibility of information within the departure station and the ease of walking to the departure station (giving these two indicators a median value of 5 out of a possible 6). Information about other mobility services available at the arrival station is considered insufficient by those who need to transfer to other modes of transport (a median of 3), which represents a serious obstacle to effective intermodal travel. The urban quality of train stations also obtains only a low average score (a median of 3), reflecting a scarcity and/or state of neglect of pedestrian areas, green spaces, sidewalks, public squares and bus stops.

We performed an ANOVA to compare train users and non-users with respect to some variables, reported in Table 2, that influence modal choice. The results show that:

- there is a statistically significant difference ($p < 0.05$) with respect to the importance attributed to the variable "travel cost" (TRVCOST), which is on average higher for train users than for non-users;
- train users significantly tend to consider the variables shown in Table 2 more important than non-users ($p < 0.05$).

The first section of the table shows the significant values, while the second shows the differences in terms of mean score. The link between habitual train use and the overall travel experience is particularly significant for train users ($p < 0.001$), who are able to use travel time for work, study, leisure activities, or simply to relax.

Concerning the correlation analysis, the perception of the quality of the nodes is rather low, especially for the items relating to "safety and urban quality". There is a highly significant positive correlation ($p < 0.001$) between the perception of the quality of a station's urban attributes (URBQUAL) and its perceived safety (SECUR), showing that respondents who report feeling unsafe inside a station also tend to perceive it as a materially degraded place. In addition, the importance assigned by respondents to the quality of

the urban landscape around a station (URBQUAL_REL) is also significantly correlated ($p < 0.001$) with two additional variables: the importance assigned to the perception of security (SECUR_REL) and the presence within the node of social/cultural gathering spaces (SOCLSPACE_REL). This indicates that people who appreciate and value urban quality also tend to see the presence of spaces for social and cultural gatherings as helping to maintain the vitality of stations and reducing the risk of abandonment and degradation.

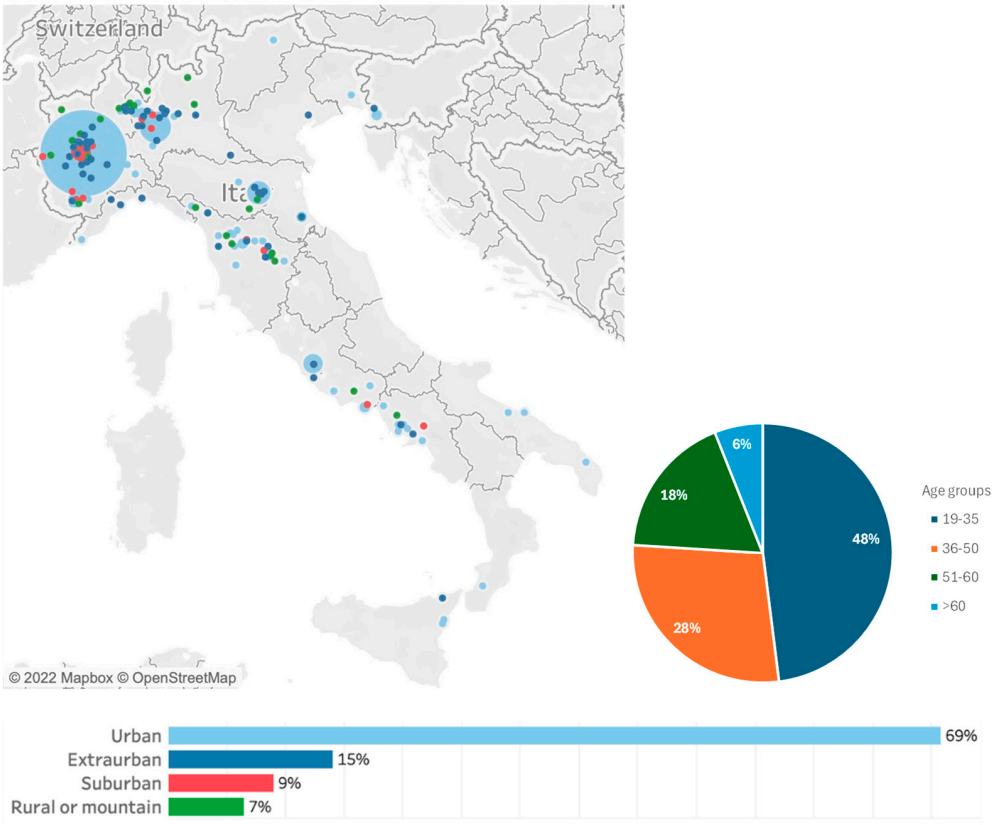


Figure 3. Geographic distribution of the sample by municipality of residence and percentage of responses by territorial context.

Table 2. Analysis of Variance (ANOVA) between the modal choice of the train (TRAINUSER) and the relevance attributed to the overall quality of the public transport system (1—Not at all important; 6—Absolutely important).

ANOVA		*p*-Value
ACC_TPL Accessibility of public transport services	Between groups	0.005
QUAL_TPL Quality of vehicles dedicated to public transport (comfort of seats, age of vehicles, cleanliness, etc.)	Between groups	0.027
TRVCOST_TPL Total cost of travel by local public transport	Between groups	0.001
TRVCOMF_TPL Comfort of travel, including transfer where applicable	Between groups	0.011
TRVEXP_TPL Overall travel experience: possibility of doing other activities during the trip on at least one of the vehicles in the sequence	Between groups	<0.001

Table 2. *Cont.*

Descriptive			
VARIABLE	**TRAINUSER**	**N**	**Average score**
ACC_TPL Accessibility of public transport services	Yes—Train user	174	5.43
	No—Non train user	207	5.14
	Total	381	5.27
QUAL_TPL Quality of public transport vehicles (comfort of seats, age of vehicles, cleanliness, etc.)	Yes—Train user	174	5.36
	No—Non train user	207	5.13
	Total	381	5.23
TRVCOST_TPL Total cost of travel by local public transport	Yes—Train user	174	5.50
	No—Non train user	207	5.36
	Total	381	5.43
TRVCOMF_TPL Comfort of travel, including transfer where applicable	Yes—Train user	174	5.16
	No—Non train user	207	4.86
	Total	381	5.00
TRVEXP_TPL Overall travel experience: possibility of doing other activities during the trip on at least one of the vehicles in the sequence	Yes—Train user	174	4.76
	No—Non train user	207	4.24
	Total	381	4.48

3.2. Exploratory Factor Analysis (EFA)

The exploratory factor analysis was conducted across all 381 sets of observations. Being the purpose of the study to understand the attitudes towards railway stations and which are the main determinants of using them for both travelling and using offered services, a selection of variables has been conducted for the EFA. Variables from section 4 of the questionnaire were selected because they aimed at collecting information on the importance people assign to the quality of stations as determinant of intermodality. Those variables focused on three main themes: (1) suggestions for measures that could encourage intermodal travel behaviour (12 variables); (2) relevance assigned to the attributes of railway stations used outside the scope of the most important trip (12 variables); (3) importance assigned to other attributes of the transport system (excluding stations) (10 variables). Twenty-four variables out of 34 were selected based on the following criteria:

- items related to stations and internal services (9 items): this criterion excluded three variables from the first theme because they referred to the characteristics of the areas surrounding the station (e.g., urban quality, presence of sharing mobility parking spaces, removal of architectural barriers, and remodelling of waiting areas);
- items not related to commuting (8 items): this criterion excluded four variables from the second theme, which are usually essential for commuters (e.g., ticket office, effectiveness of connections with public transport stops, presence of park-and-ride facilities, quality of the surrounding landscape);
- items not related to commuting (7 items): similar to the second theme, this criterion excluded three variables not relevant for non-commuting travels (e.g., importance of MaaS platforms, travel time and cost of the whole trip chain).

In addition, a correlation analysis between the variables was conducted, which confirmed the very low commonality of the excluded variables [53]. The 24 variables selected for the EFA are reported in Table 3.

By factoring the principal axes, following the eigenvalue criterion and the "elbow" of the scree plot, the six extracted latent factors can account for 61.12% of the cumulative variance (with the first latent factor accounting for 29.7%). We considered this percentage to be a good value, as it was consistent with the lower limit of 60% [53]. The final output of the analysis is represented by six factors shown in Table 4.

Table 3. Description of the final 24 variables considered in the exploratory factor analysis.

Variable	Description
SOCLSPACE_IN	Importance that stations offer spaces for social and cultural events
SOCLSPACE_REL	Likelihood of greater train use if spaces for social and cultural events in the station
COWRKSPACE_IN	Importance that stations offer spaces for coworking
RETAIL_IN	Importance that stations offer commercial/retail services
RETSERV_REL	Likelihood of greater train use if commercial/retail services in the station
TRVEXP_TPL	Importance of the overall travel experience: possibility of engaging in other activities during the trip
ACC_TPL	Importance that public transport services are accessible
PMRACC_REL	Likelihood of greater train use if the station easily accessible by those with reduced mobility
PEDACC_REL	Likelihood of greater train use if the station easily accessible by pedestrians
TRVCOMF_TPL	Importance of the overall comfort of travel, including comfort of transfer where applicable
QUAL_TPL	Importance of the quality of public transport vehicles (comfort of seats, age, cleanliness, etc.)
LIGHT_UP	Importance of improved station lighting
WAYFNDNG_UP	Importance of improved wayfinding systems (vertical and horizontal signage) in the station
ELEV_UP	Importance of improved elevators, escalators, etc.
WAYLINE_UP	Importance of linearizing and simplifying pedestrian paths connecting to the station
PULINT_REL	Likelihood of greater train use if better interior cleanliness
SECUR_REL	Likelihood of greater train use if better perceived safety
PULEST_REL	Likelihood of greater train use if better exterior cleanliness
DISP_TPL	Importance of the availability of public transport services
COORD_TPL	Importance of coordinating public transport services and integrating schedules
FREQ_TPL	Importance of frequent public transport services
BIKEPATH_UP	Importance of improved bicycle lanes connecting to the station
BIKEPARK_IN	Importance of improved secure bicycle parking
BIKEACC_REL	Likelihood of greater train use if the station easily accessible by cyclists

Table 4. Extracted factors with loadings and related assigned name.

	Factors [a]					
	1 Sociality and Living	**2 Accessibility and Overall Quality**	**3 Walkability**	**4 Cleanliness and Safety**	**5 Transport Services Planning**	**6 Cycling Accessibility**
SOCLSPACE_IN	0.861					
SOCLSPACE_REL	0.820					
COWRKSPACE_IN	0.772					
RETAIL_IN	0.576					
RETSERV_REL	0.537					
TRVEXP_TPL	0.453					
ACC_TPL		0.735				
PMRACC_REL		0.656				
PEDACC_REL		0.646				
TRVCOMF_TPL		0.620				
QUAL_TPL		0.595				
LIGHT_UP			0.810			
WAYFNDNG_UP			0.706			
ELEV_UP			0.704			
WAYLINE_UP			0.704			
PULINT_REL				0.960		
SECUR_REL				0.715		
PULEST_REL				0.677		
DISP_TPL					0.853	
COORD_TPL					0.813	
FREQ_TPL					0.757	
BIKEPATH_UP						0.773
BIKEPARK_IN						0.706
BIKEACC_REL						0.651

Extraction method: Principal axis factorization; Rotation method: Promax with Kaiser normalization. [a] Convergence for rotation performed in 6 iterations.

We labelled the six latent factors as follows: "sociality and living"; "accessibility and overall quality"; "walkability"; "cleanliness and safety"; "transport services planning"; and "cycling accessibility".

The first factor, sociality and living, reflects the social role that the train station plays in the urban fabric. Offering spaces that can shape the daily life of citizens events, conferences, cultural initiatives, coworking or study, commercial activities and services is consistent with the station's recognised social significance and helps realise its potential for improving the quality of people's lives.

The second latent factor, accessibility and overall quality, comprises variables that characterise the quality of the public transport system and its capacity to provide access to transport services as a whole. People's readiness to use public transport in general, and the train in particular, is closely linked to the "physical impedance" of public transport vehicles and services, as well to the infrastructural design and maintenance of interchanges (shelters, sidewalks, barriers). Poor quality interchanges can make the transport system less appealing as it negatively affects the overall travel experience.

Walkability, the third factor, brings together all the elements that characterise pedestrian flows within an interchange. Whether or not people choose intermodal travel strongly depends on the timing and convenience of the transfer. The improvement of pedestrian routes within nodes (lights, signage, architectural barriers) has a significant potential to reduce the inconvenience of moving between one means of transport and another.

The fourth factor, cleanliness and safety, corresponds to what is seen as train stations' major weakness. This also emerged in the descriptive phase of the analysis: safety and cleanliness variables are important decision-making drivers for respondents. It follows that architectural and/or functional reconfigurations of stations must in all cases be accompanied by careful plans and actions for their upkeep and safety.

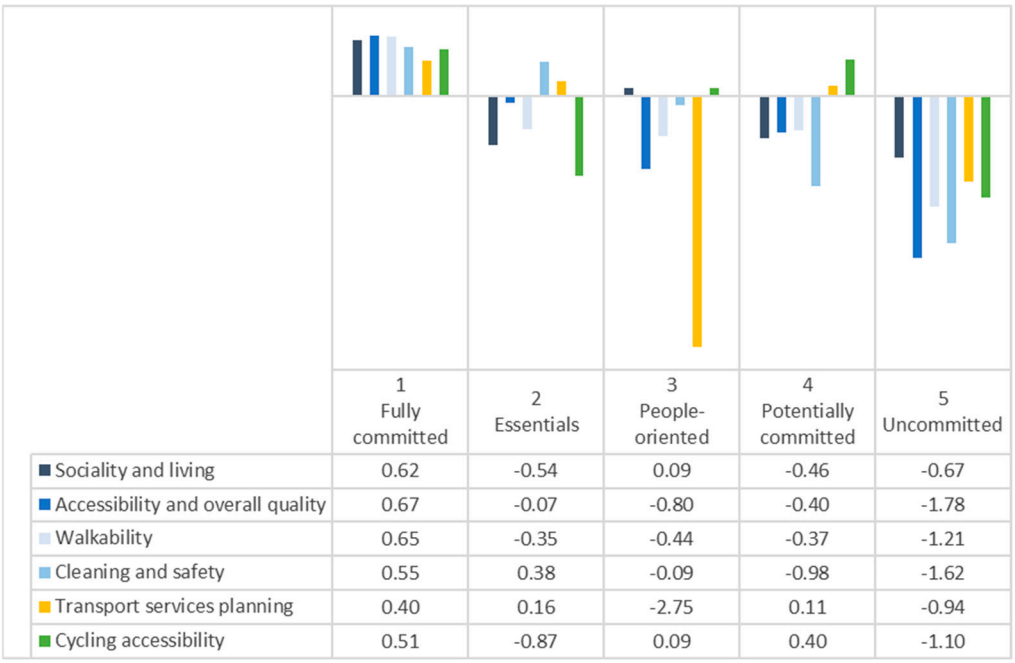
The fifth factor, transport services planning, is related to the overall quality of the public transport system: the availability, frequency, and integration of services are in fact the three pillars on which a truly effective transport planning process rests, such that the public can be offered a viable alternative to the private car, regardless of the infrastructural quality of interchange nodes.

The sixth latent factor, cycling accessibility, concerns the accessibility of stations via cycling and electric micro-mobility. For these to be strong alternatives over the first and last mile, there must exist a safe and extensive cycle network, as well as places where bicycles and e-scooters can be safely stored when not being transported by train.

3.3. Cluster Analysis

Five clusters were obtained, that we labelled as "fully committed", "essentials", "people-oriented", "potentially committed", and "uncommitted". Figure 4 shows the five clusters; the coloured bars in the upper part of the chart represent the observed distance from the centroids for each latent factor, which gives an idea of how the topics represented by that factor are viewed by the cluster. The sizes of the five clusters are shown in Figure 5.

The first cluster includes the individuals defined as fully committed, that is to say who consider all the identified latent factors important (all having values above the average), whether these latent factors relate exclusively to train stations or also to other attributes of the transport services. In particular, "accessibility and overall quality" (0.665) is the factor that appears chiefly to characterise the respondents' choices, together with the "walkability" factor (0.651). Broadly stated, this group shows the greatest overall commitment to intermodality, sustainable mobility and the urban regeneration of station areas.



	1 Fully committed	2 Essentials	3 People-oriented	4 Potentially committed	5 Uncommitted
Sociality and living	0.62	-0.54	0.09	-0.46	-0.67
Accessibility and overall quality	0.67	-0.07	-0.80	-0.40	-1.78
Walkability	0.65	-0.35	-0.44	-0.37	-1.21
Cleaning and safety	0.55	0.38	-0.09	-0.98	-1.62
Transport services planning	0.40	0.16	-2.75	0.11	-0.94
Cycling accessibility	0.51	-0.87	0.09	0.40	-1.10

Figure 4. The five clusters and their profiles.

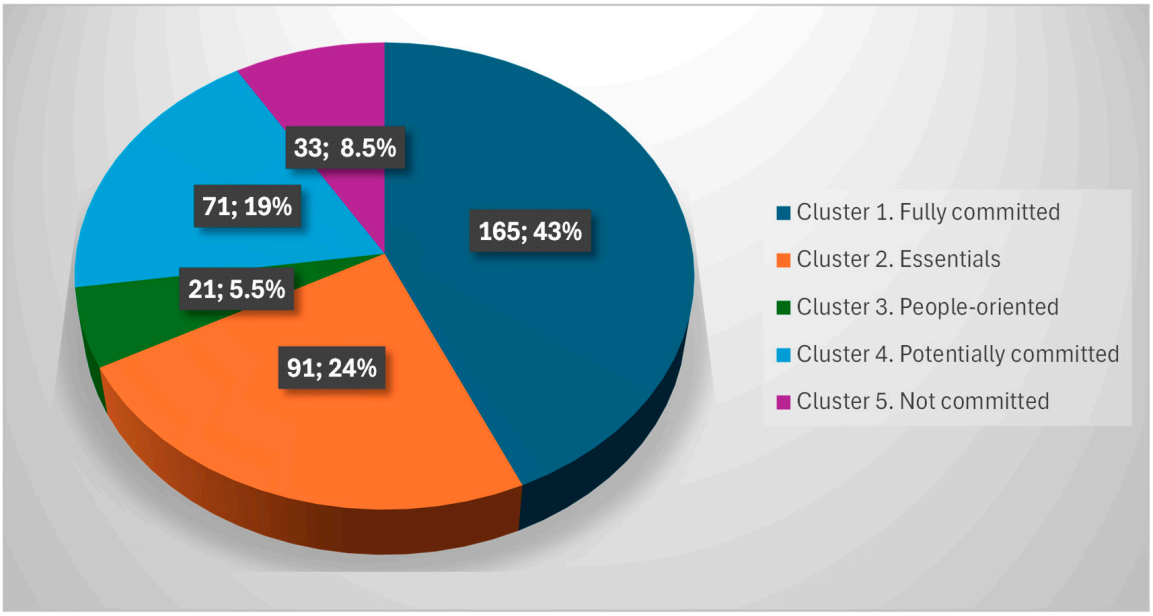


Figure 5. Breakdown of the sample into the five clusters.

The second group of individuals, the essentials, tend to place more value on elements that some might see as basic, minimum requirements in the public transport system and its intermodal nodes, essentials' two most important latent factors being "cleanliness and safety" (0.380) and "transport services planning" (0.165). For essentials the other factors carry less weight, in particular "sociality and living" (−0.536) and "cycling accessibility" (−0.868). This cluster could potentially find intermodality and public transport more attractive if there were a good integration of services, together with cleaner and safer stations, given that they see these aspects as essential attributes for potentially choosing rail services for commuting.

The third, people-oriented, group of individuals place slightly greater importance on aspects relating to "sociality and living" (0.092) and "cycling accessibility" (0.088), while neglecting other factors, in particular "transport services planning" (−2.752). Their profile

seems to point to individuals who are concerned about how train stations can improve their quality of life, as regards stations' potential in triggering improvements to the cycle network, and their emerging role as urban places, in a new people-centred approach that goes beyond stations' exclusive function as transport nodes.

Individuals belonging to the fourth cluster, potentially committed, accord more weight to the factors "transport services planning" (0.114) and "cycling accessibility" (0.403). Intermodality could therefore be made more attractive to this group of people via the provision of well-organised public transport services (in terms of availability, frequency, timetable, etc.) where the first and last mile were better adapted to cyclists. These two factors are thus potential opportunities to change travellers' habits.

Finally, the fifth cluster, uncommitted, includes individuals for whom all the latent factors have values below the average. This group of respondents would appear to have no interest in trying to change their mobility habits towards rail and intermodality. They simply do not consider public transport as a viable alternative, and this would remain the case even if intermodal hubs and transport services were to be improved.

The five clusters obtained were shown by the Kruskal–Wallis test to be statistically different in terms of age, household size, and the territorial context of door-to-door travel (TRIPCNTXT), although not statistically different as regards car ownership.

4. Discussion and Policy Recommendations

The research focused on how a part of the demand for transport might potentially be shifted towards rail transport and intermodality via a series of actions targeting both transport supply and the quality of nodal infrastructures.

In terms of people's mobility habits, it emerged, as might be expected, that soft mobility is used more in urban areas, while suburban areas are characterised by a high level of private car use. For this to change, as we have seen, a real paradigm shift is required in the way we think about and organise urban/suburban spaces.

Our study looked at the first- and last-mile travel habits of train users (46% of the sample) on their "most important trip". Although the car was found to be the most commonly used means of starting the journey to the station, for the final mile walking was the predominant mode, followed by local public transport. A residual share is accounted for by cycling, which thus remains an underused potential, often because of the lack of a widespread and effective cycling network, as also found by previous works [8].

The study also revealed poor perceptions of the urban quality of station surroundings, this item being strongly correlated with perceived safety, also assessed negatively by respondents. Other works report a similar correlation [10]. This type of analysis has thus identified deficiencies in the quality of station construction, reinforcing the thesis that the aesthetic and architectural quality of train stations should in fact be "explicit design variables", as also mathematically modelled by Cascetta et al. [26]. At the same time, actions to improve the functionality of pedestrian routes (architectural barriers, lighting, wayfinding) are also considered important for making transfers as comfortable as possible. In addition, there is a strong correlation, also observed by other researchers [7], between perceived urban quality and the presence of spaces for social, work and cultural frequentation, which helps to underline how a "living" place can potentially mitigate the risk of urban (and social) degradation of central city locations, while simultaneously promoting walking and cycling.

These findings reflect our latent factor "sociality and daily life", which points to the importance that people place on the vitality of urban places. However, the other factors show that when considering whether and how to change or maintain their intermodal mobility habits, people ultimately tend to consider:

- the overall quality of public transport services;
- the cleanliness and safety of the train stations;
- the walkability of connections within the node;
- the possibility of reaching the station by bicycle.

These results demonstrate that the "Node-Place model" is less effective in evaluating transport nodes when considering only transport supply and accessibility, while the "TOD Index approach", despite including a greater number of variables, does not adequately reflect people's attitudes towards nodes, which are the variables that most influence travel behaviour.

Our profiling of respondents showed a good propensity for intermodality, with only small percentages of people completely uninterested in changing their mobility habits. A substantial proportion of respondents (43%), on the other hand, would potentially be inclined to choose rail transport if at least some of the proposed measures were implemented, but were unable to identify a single, clear priority. Although this indicates a good level of involvement, it is a result that is of little use for supporting policy makers. However, a clearer indication emerges indirectly from the two groups of essentials and potentially committed users (together 43% of the sample). Both categories of people tend to appreciate the quality and organisation of services and, at the same time, are able to identify some priorities for policies and actions. To this end, two areas of interventions are proposed to infrastructure managers and administrations: the stations and the access to the stations. Concerning the first policy recommendation, we refer to interventions on stations, articulated in the different aspects emerged from the survey.

The first consideration is that clean and well-maintained stations are safe stations. The finding that emerges most clearly from our survey and from others [6] is that the critical issues putting people off using train stations relate to perceived safety, upkeep and cleanliness. Concerted actions targeting these aspects, with careful plans for the cleaning and maintenance of fixtures, as well as surveillance, could be a first step in encouraging people to use train stations and, by extension, rail transport. A key finding in support of this hypothesis is the correlation that can be observed between perceived safety and urban/building quality, which can therefore also indirectly influence people's sense of safety.

Secondly, there appear to be good reasons for encouraging people to use stations, regardless of whether they intend to take the train. The provision of social and community spaces, meeting centres, events venues, shopping areas, study rooms and coworking offices is an element that can add value, especially in case of medium-large train stations, strengthening their role as attractive poles of city life. The demographic that responds most favourably to this kind of provision are people (such as commuters and students) who tend to use medium to long-distance rail services for travel between cities. However, our study also indicates that the "vitality" of an urban place is indirectly related to people's feelings of safety and well-being, and attractive, vibrant places are less likely to suffer from urban and social degradation and abandonment. This outcome might be an argument for infrastructure managers and rail operators to examine the value of their stations also in relation to non-travel related activities. Stated slightly differently, our study shows that attractiveness of a station can also potentially derive from services (not necessarily directly related to travel) that increase the value of the infrastructure as a place designed for people.

Based on these outcomes, to encourage people to use stations and public transport, we propose interventions on stations based on and approach integrating visual with functional aspects to create a "station landscape" characterised by pleasantness, safety, and comfort. Infrastructure managers in charge of railway station construction, maintenance, and management, should invest in co-creation of solutions with travellers to discover the

relationship between the perception of the station landscape and the psycho-physiological responses of users, identifying the characteristics of the station that have an impact on users, to optimise station spaces by orienting them towards "well-being". Our results showed that cluster n° 3 (people oriented) is a small group of people with high attitude towards sociality and living that could be an excellent panel to test our proposal. Bringing users and operators closer together and encouraging them to collaborate is the starting point for designing the stations and transport systems of the future, creating meeting places that promote socialising and exchange, giving public transport and its hubs a new look—no longer ugly and dangerous places, but pleasant places to visit, a bridge to the growing use of public transport. The second policy recommendation refers to access to stations. The provision of adequate cycling infrastructures for station access and the possibility of using bicycles (and micro-mobility in general) for the first/last mile constitute a second priority for action. This is an area of real potential in both urban and suburban settings, where cycling to and from stations can represent a concrete alternative, potentially compensating for some of the deficiencies of the public transport system. Policy and investment need to be directed towards the creation of a widespread and safe cycle network connecting railway nodes, as well as secure parking spaces for those who prefer not to take their bicycle on board the train. This proposal is supported by SUMPs (Sustainable Uran Mobility Plans) in several Italian metropolitan areas with particular focus on suburban and rural areas. These areas suffer from a lack of last mile connections from industrial and sparsely populated residential areas to railway stations. This hinders the use of public transport and often makes intermodality an impractical option. At the policy level, there is awareness of the urgent need to create adequate cycle networks to improve accessibility to public transport hubs. However, there are two main obstacles: (a) the lack of data of transport demand, which prevents the adequate design of a cycle network capable of meeting the mobility needs of people living in the different areas; (b) the lack of financial resources, which are even more difficult to obtain if the previous problem is not resolved. The proposed solution is to plan travel surveys to identify mobility needs, including the psychosocial variables used in our survey to correctly identify the routes of the cycle network. Both interventions require investment, which is a sore point in Italy. However, the current National Recovery and Resilience Plan (PNRR) could represent a great opportunity to invest in the creation of a new concept of station, one that is social, inclusive and safe.

The policy recommendations are not only valid for Italy, because our results confirm what has been found in most of the literature, as discussed above. In fact, some steps towards the proposed policies have been taken in other European countries. For example, in France there is a strong focus on the liveability of stations, although interventions are often driven by commercial interests and are not based on users' mobility needs, as demonstrated by the controversy over the new concept for the Gare du Nord in Paris. The Nordic countries, on the other hand, are the most advanced in terms of cycling thanks to a long-standing culture of bicycle use. However, what seems to be common to most countries is the lack of data that brings together traditional and psychosocial information to support a new design approach to infrastructure and hubs. https://theconversation.com/quand-la-gare-du-nord-dechaine-les-passions-decryptage-dune-polemique-125442 (accessed on 1 June 2025)

5. Conclusions

Our findings confirm some of the results of previous studies but emphasise the importance of considering psychosocial variables in order to better understand people's attitudes and identify the variables that can spur a behavioural change. From this point

we propose some policy recommendations seeking to engineer a consistent behavioural change in people's travel habits through promoting sustainable commuting and rail use.

Despite the limited size of the sample and the strongly territorial nature of the research, this initial investigation provides insights into people's perceptions of certain aspects of Italian train stations, from which we may derive a ranking of the actions that have a potential to make stations more accessible and attractive. Although we did not ask for information about station characteristics or spatial context, we know the city of origin and destination of train users. These stations cover all major Italian cities (Turin, Milan, Bologna, Florence, Rome) that have a high-speed rail service, as well as many medium-sized and small cities in rural areas. Although the proposed policies are applicable to different types of stations, as they are based on users' perception and desires regarding what they expect from a railway station, we cannot tailor recommendations to specific types of stations.

Given the initial promising outcomes, which carry implications for urban planning, the survey might usefully be relaunched at a future date to reach a wider community of people across different Italian regions, to provide a clearer understanding as regards different urban contexts and local policies.

Author Contributions: Conceptualization, C.P. and F.T.; methodology, C.P.; software, F.T.; validation, C.P. and A.B.M.; formal analysis, F.T.; investigation, C.P. and F.T.; resources, C.P.; data curation, C.P. and F.T.; writing—original draft preparation, F.T.; writing—review and editing, C.P. and A.B.M.; visualization, F.T.; supervision, C.P.; project administration, C.P. and F.T.; funding acquisition, C.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The datasets generated during and analysed during the current study are not publicly available due to sensitive information.

Acknowledgments: The authors thank all the companies and associations that have kindly supported the dissemination of the link to the questionnaire, notably RFI, Legambiente, Pendolaria, several commuters associations, and RFI.

Conflicts of Interest: The authors declare no conflicts of interest.

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