PERCEIVED ACCESSIBILITY OF TRANSPORT SYSTEMS IN ITALY: A STATISTICAL ANALYSIS USING "ASPECT OF DAILY LIFE" SURVEY[1]

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Abstract. This study aims at exploring transport accessibility in Italy using data from the Aspect of Daily Life survey conducted by the Italian National Statistical Office (ISTAT). The aim is to identify the main determinants of perceived accessibility, in order to guide targeted policy interventions focused on improving public transport perceptions. The methodological framework is based on Covariance based - Structural Equation Modelling (SEM). The results indicate that confidence towards local and national institutions as well as transport affordability increase the perceived accessibility of public transports. Moreover, the quality of the local viability is negatively related with accessibility perception of public transportation.

1. Introduction

Ensuring access to essential services, including transport, is a cornerstone of social inclusion and sustainable development. Transport accessibility plays a crucial role in enabling individuals to reach opportunities such as employment, education, healthcare, and social participation, thereby influencing quality of life and spatial equity. In particular, Goal 11.2 of the United Nations Sustainable Development Goals (SDG) calls for "access to safe, affordable, accessible and sustainable transport systems for all," highlighting the need to address the needs of vulnerable groups (United Nations, 2021). According to the European Commission (2021), the European Pillar of Social Rights (EPSR) further strengthens the political relevance of transport accessibility. Principle 20 of the EPSR defines access to essential services—including transport—as a fundamental right for all, with specific emphasis on quality, availability, affordability, and universal coverage, especially for people in precarious conditions or at risk of poverty.

In Italy, disparities in transport infrastructure and service coverage are particularly pronounced. According to ISTAT (2023), while more than 90% of the population in Lombardia can reach a railway station in under 30 minutes by car, the same percentage drops below 40% in Calabria. These sharp regional contrasts reflect

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deeper spatial and social inequalities that call for the development of robust, multidimensional measures of accessibility to support targeted and evidence-based policies.

Ensuring equal access to opportunities requires going beyond infrastructure-based indicators and considering how individuals perceive the accessibility of transport systems in their daily lives. As argued in the literature, accessibility is a key factor in promoting spatial equity and enabling social participation, particularly for disadvantaged groups (Handy and Niemeier, 1997; Delbosc and Currie, 2011; Litman, 2014). A growing body of research highlights the importance of adopting multidimensional, perception-sensitive approaches to capture individuals' actual experiences and constraints (Tahmasbi and Haghshenas, 2019).

In this regard, perceived accessibility has been defined as the subjective evaluation of travel conditions—such as time, comfort, and reliability—filtered through individual preferences and needs (Friman *et al*., 2020; Jamei *et al*., 2022). Among existing frameworks, the “modal-focused” approach assesses satisfaction with specific transport modes and is increasingly used to understand user-oriented service quality (Friman *et al*., 2020; Sundling *et al*., 2014).

In this context, this study aims at exploring perceived accessibility of transport systems in Italy, using microdata from ISTAT’s *Aspects of Daily Life* survey. The objective is to identify the main determinants shaping citizens’ perception of transport accessibility and to provide a comprehensive understanding of the phenomenon. Given the interdependent and latent nature of the dimensions involved,a Covariance-Based Structural Equation Modelling (SEM) framework is adopted, thus allowing for simultaneous estimation of direct and indirect relationships between observable indicators and unobservable constructs.

The empirical results reveal that perceptions of accessibility are significantly influenced by a combination of contextual and individual-level factors. Specifically, satisfaction with public transport services, affordability, perceived quality of the surrounding environment (traffic and available parking), and trust in institutions exhibit statistically significant and positive effects on perceived accessibility.

The remainder of the paper is structured as follows. Section 2 outlines the methodological framework, with a focus on the construction and estimation of the SEM and presents the data sources with indicators used. Section 3 discusses the main empirical findings. Finally, Section 4 draws conclusions and outlines key policy implications, offering directions for future research on inclusive and sustainable transport accessibility.

2. Method and data

2.1 Method

This study employs a Covariance-Based Structural Equation Modelling (CB-SEM) approach to assess the relationship between perceived accessibility of public transport and its underlying determinants. CB-SEM was chosen over Partial Least Squares SEM (PLS-SEM) since the goal is to confirm theoretical assumptions rather than predict endogenous variables, following the recommendations of Hair *et al*. (2021). SEM is particularly suitable for models involving latent constructs measured indirectly by multiple indicators, as it accounts for measurement error and estimates both direct and indirect relationships simultaneously.

The model includes four latent constructs: Administration, capturing trust in national, regional, and local institutions (Pagliara *et al*., 2021; Van de Walle & Bouckaert, 2003); Environment, reflecting perceptions of neighborhood conditions such as traffic and parking (Zhu *et al.*, 2024); Affordability, based on indicators of economic satisfaction; and Perceived Accessibility, the core outcome variable, aimed at evaluating satisfaction with different aspects of public transport, in line with the modal-focused framework by Friman *et al.* (2020) and subsequent studies. From the dataset we extracted valuations for trains, buses, and pullman for several perceived accessibility attributes variables. Subsequently, we created composite indicators for each accessibility attribute.

We followed the reflective-formative (Type II) model structure (Afthanorhan, 2014), in which structural arrows point from independent to dependent latent constructs, and measurement arrows point from latent constructs to their respective observable indicators. Prior to model estimation, we tested the data for multicollinearity using the Variance Inflation Factor (VIF), ensuring all values were below the critical threshold of 5 (Akinwande *et al.*, 2015). Normality was assessed via skewness (<2) and kurtosis (<7), following West *et al.* (1995). Exploratory Factor Analysis (EFA) was conducted to assess indicator correlation (>0.3), and Spearman's rank correlation coefficient was used to evaluate relationships among variables (Habing, 2003; Ritter, 2012). Model estimation was performed using the lavaan package in RStudio, and visualization of the model structure was generated using the Semplot package. Missing values were handled through Full Information Maximum Likelihood (FIML) estimation.

2.2 Capturing Perceptions of Accessibility: Data from the Aspects of Daily Life (ADL)

The empirical analysis is based on microdata for research purposes taken from 2022 edition of the “Aspects of Daily Life” (AVQ) survey, conducted by ISTAT.

The survey is part of the Multipurpose Survey system and provides nationally representative microdata on individual and household well-being. The 2022 wave includes information from approximately 20,000 households and over 45,000 individuals, collected through a two-stage stratified sampling design. In the first stage, municipalities were selected and stratified by region and demographic size; in the second stage, households were randomly drawn from municipal registry lists. Table 1 presents the full list of observed variables, grouped by latent construct, including descriptions and bibliographic sources.

Table 1− *Variables included in the model.*

Latent variable	Variable	Variable description	Source
Administration	TRUST1	Trust for parliament	(Pagliara *et al*., 2021; Geert Bouckaert and Van de Walle, 2003; Van de Walle, 2003)
	TRUST2	Trust for regional government	
	TRUST3	Trust for municipality government	
Environment	CONGESTION	Perception of traffic intensity in the district of residence	(Zhu *et al*., 2024)
	PARKING	Perception of available parking in the district of residence	
Affordability	AFFORDABILITY1	Perception of economic satisfaction compared to the previous year	
	AFFORDABILITY2	Perception of economic satisfaction	
Perceived Accessibility	TIME	Satisfaction with the time of public transport	(Friman *et al*., 2020; Ismael and Duleba, 2021; Jamei *et al*., 2022; Mabkhot *et al*., 2024; Tanwar *et al*., 2024)
	COST	Satisfaction with the cost of public transport	
	PUNCTUALITY	Satisfaction with the punctuality of public transport	
	CLEAN	Satisfaction with the cleanness of public transport	
	WAITING	Satisfaction with the waiting time of public transport	
	SEATS	Satisfaction with the seats of public transport	
	SPEED	Satisfaction with the speed of public transport	
	CONNECTION	Satisfaction with the connection of public transport	

Source: Own elaboration based on ADL data.

To ensure the adequacy of the measurement model, reliability and convergent validity were evaluated. Following the criteria proposed by Fornell and Larcker (1981), Table 2 reports the values of Composite Reliability (CR), and Average Variance Extracted (AVE) for each latent construct. Following the work of Vincókzi *et al*. 2025 the values of Cronbach's alpha were also included. All constructs meet the recommended thresholds, confirming acceptable levels of internal consistency and convergent validity.

Table 2 - *Summary of exploratory factor analysis.*

Type of fit	Statistical Index	Test value	Threshold	Source
Administration	Cronbach-alpha	0.883	>0.600	(Vincókzi *et al.*, 2025)
	Composite reliability (CR)	0.888	>0.600	
	Average Explained Variance (AVE)	0.725	>0.500	
Environment	Cronbach-alpha	0.661	>0.600	
	Composite reliability (CR)	0.661	>0.600	
	Average Explained Variance (AVE)	0.494	>0.500	
Affordability	Cronbach-alpha	0.654	>0.600	
	Composite reliability (CR)	0.660	>0.600	
	Average Explained Variance (AVE)	0.495	>0.500	
Accessibility Perception	Cronbach-alpha	0.899	>0.600	
	Composite reliability (CR)	0.901	>0.600	
	Average Explained Variance (AVE)	0.534	>0.500	

Source: Own elaboration based on ADL data.

All items demonstrated acceptable levels of reliability and validity: item loadings exceeded 0.5, Cronbach's alpha and Composite Reliability (CR) values were above 0.6 for all constructs and Average Variance Extracted (AVE) values were acceptable (>0.5) or (≥0.4) if (CR > 0.6) (Fornell and Larcker, 1981; Vincókzi *et al.*, 2025). The regression weights for the best version of the model, obtained after testing various different indicators, are presented in Table 4 and Table 5. Bearing in mind the methodological framework and the available data, the specification of the model estimated in this paper is reported in the Appendix (Figure 1).

3. Results

The coefficient of determination (R^2) for the endogenous variable exceeds the 0.1 threshold (Ozili, 2022), confirming the statistical adequacy of the estimated model, which includes four latent constructs and fifteen observed indicators. Model fit was assessed using a comprehensive set of indices—absolute fit, incremental fit, non-centrality-based, and parsimony indices. As shown in Table 3, all indicators fall within acceptable ranges, supporting the model's overall goodness of fit (Vincókzi *et al*., 2025; Newsom, 2025; Rožman *et al*., 2020).

Table 3 - *Measures of model fit.*

Type of fit	Statistical Index	Test value	Threshold	Source
Absolute fit	GFI (goodness of fit index)	0.993	>0.800	(Vincókzi *et al.*, 2025; Newsom, 2025; Rožman *et al.*, 2020)
	RMSR (root mean square residual)	0.002	<0.08	
	SRMR (standardized root mean square residual index)	0.031	<0.08	
Relative Fit Indices	NFI (Normed fit index)	0.961	>0.900	
	IFI (Incremental Fit Index)	0.962	>0.900	
	TLI (Tucker-Lewis-index	0.952	>0.900	
Noncentrality-base Indices	RMSEA (root mean square error of approximation)	0.041	<0.100	
	CFI (comparative fit index)	0.962	>0.900	
Parsimony fit Indices	PGFI (parsimony-adjusted goodness of fit index)	0.618	>0.500	
	PCFI (parsimony-adjusted comparative fit index)	0.769	>0.500	
	PNFI (parsimony-adjusted normed fit index)	0.769	>0.500	

Source: Own elaboration based on Questionnaire data.

The measurement model confirms the robustness of the latent constructs. As reported in Table 4, the path loadings for all observed variables are statistically significant ($p < .001$), with estimates exceeding the minimum recommended threshold of 0.5. The items CONNECTION, TIME and CLEAN—both related to satisfaction with public transport—show the highest loading values, suggesting their central role in shaping perceived accessibility.

Table 4 - *Results of measurement model.*

Observable variable	Latent variable	β (Estimate)	SE	z	p
TRUST1	Administration	0.991	0.006	169.627	<.001
TRUST2	Administration	1.184	0.006	185826	<.001
TRUST3	Administration	1.000	-	-	-
CONGESTION	Environment	1.000	-	-	-
PARKING	Environment	1.037	0.058	17784	<.001
AFFORDABILITY1	Affordability	1.000	-	-	-
AFFORDABILITY2	Affordability	0.827	0.032	25.688	-
TIME	Perceived_accessibility	0.964	0.010	97153	<.001
COST	Perceived_accessibility	0.863	0.011	76630	<.001
PUNCTUALITY	Perceived_accessibility	0.930	0.010	91.809	<.001
CLEAN	Perceived_accessibility	0.992	0.011	91199	<.001
WAITING	Perceived_accessibility	1.000	-	-	-
SEATS	Perceived_accessibility	0.819	0.010	83488	<.001
SPEED	Perceived_accessibility	0.865	0.009	92804	<.001
CONNECTION	Perceived_accessibility	0.959	0.010	92.376	<.001

Source: Own elaboration based on Questionnaire data

The results of the structural model show that the Environment factor has a negative and statistically significant direct effect on the accessibility perception of public transportation services (Table 5). This aligns with the findings of De Vos *et al.* (2025), who asserted that public transit is most attractive to commuters who face less congestion. Moreover, parking availability in Italy has a significant influence on the commuter's perceived accessibility towards the public transport system; Countries where cars are the main transport mode will need more parking slots than nations that have public transport as a dominant mode (Widiyani *et al*., 2023). Trust in institutions impacts accessibility perception of public transport, in a similar vein to the work of Lim and Moon (2021), where trust in institutions has a direct and positive effect on the behavioral intentions of supporting public transport spending. The results confirm the relationship shown by Pagliara *et al*. (2021), but looking in the opposite direction, from trust to perception. The results are also in line with the findings of Van de Walle (2003); existing levels of trust in government may also have an impact on perceptions of government performance.

Table 5 - *Results of the structural model.*

Observable variable	Latent variable	β (Estimate)	SE	z	p
Perceived accessibility	Administration	0.24	0.008	29967	<.001
Perceived accessibility	Environment	0.107	0.009	11708	<.001
Perceived accessibility	Affordability	0.050	0.013	3788	<.001

Source: Own elaboration based on Questionnaire data

The analysis indicates that the *Affordability* factor has a positive and statistically significant direct effect on the accessibility perception of public transport services. This aligns with the findings of Zhu *et al*. (2024), who asserted that transport and housing affordability increases accessibility perception of public bus.

4. Conclusions

This study contributes to the growing body of research on perceived accessibility by exploring how Italian citizens evaluate their access to public transport services, using nationally representative microdata from ISTAT's *Aspects of Daily Life* survey. By employing a CBS-SEM framework, we were able to disentangle the multidimensional nature of transport accessibility and assess the relative influence of contextual and perceptual factors.

Congested areas and limited parking spots may impede the access to public transport in the Italian context. Moreover, restricting parking spaces may not increase the perceived accessibility of public transit. The lower perception of accessibility related to lower economic satisfaction may be determined by the poorer quality of public transportation in the residential areas where people with low economic satisfaction live, but also by the cost itself of public transport. In addition, economically satisfied individuals may have smaller consequences related to public transportation lacks since with greater possibility of obtaining an alternative solution. Concerning trust for the various institutions, interventions in other sectors that increase institutional trust, may improve the perception of accessibility of public transport.

These findings align with European policy priorities, notably Principle 20 of the EPSR, which affirms the right to accessible essential services for all, and the SDG

11.2 target on sustainable transport. Yet, current statistical frameworks often fail to fully capture the perceptual dimension of accessibility, which this study shows to be essential for policy targeting and equity assessments.

Moreover, the results underscore the importance of integrating perception-based indicators into national and EU-level monitoring systems could help better identify local needs, particularly in underserved or vulnerable areas.

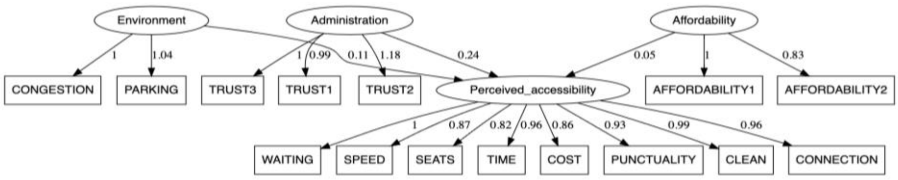
According to Afthanorhan (2014) identification issues usually exist in CB-SEM when the latent construct consists below four indicators. Thus, the researchers may use pooled confirmatory factor analysis CFA, although PLS-SEM is much easier to handle since this method can use a single item for estimation.

Formative or a mixed Formative - Reflective measurement model may be more correct to interpret accessibility perception, due to complex differences among observable indicators inside the same concept. The Formative model in PLS-SEM is easier to handle than CB-SEM, offering the possibility to consider both measurements. Future developments may consider testing the moderating effect and/or mediating effects. Future research should build on this modal-based multidimensional SEM approach by incorporating demographic, ownership and other environmental variables using microdata from ISTAT's Aspects of Daily Life survey and incorporating public transport interventions from other sources of data. Finally, it is important to measure residential characteristics with high granularity in order to understand the factors that influence perception on a local scale. Such efforts are crucial for designing inclusive and sustainable transport policies that respond not only to where people live—but to how they live and move.

Appendix

Code: Filippo955. Repository: Accessibility. [URL]

Figure 1 - *Path diagram of the model.*



Own elaboration based on Questionnaire ADL-Istat data

Acknowledgements

We would like to express our gratitude towards Francesco Maria Morosini for collaboration with data collection. This research received a research grant from PRIN HAC VIA and from Technopole Rome (Project code: P2022EY3H8).

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