MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 36 Issue 1s, 2026, Pages: 1443-1446

Shared Electric Scooters and Urban Traffic Congestion: Analysis using SEM

Corresponding author- Mrs Sushma N
Research scholar, Department of FOMC, PES University, 100 Feet Ring Road BSK III Stage, Bangalore – 560085, India,
sushma.nb5@gmail.com
Dr. Roopa J
Assistant Professor, Department of FOMC, PES University, 100 Feet Ring Road BSK III Stage, Bangalore – 560085, India,
roopaj@pes.edu

Abstract:

Urbanization has been accelerating rapidly, with cities emerging as key centres for economic activity, employment, and innovation. As urban populations continue to grow, there is an increasing need for effective planning and innovative mobility solutions to improve daily commuting. In many countries, shared e-scooters have been explored as a potential alternative to address rising traffic congestion. Against this backdrop, the present study seeks to answer the following research questions: (1) What factors influence the adoption of shared e-scooters in the urban context of Bangalore? (2) Among these factors, which ones play a more significant role in reducing the traffic congestion in Bangalore? In addition, the study highlights key research gaps identified through the literature, which may guide future investigations. Statistical analysis has been carried out using Jamovi (version 2.7.12). An effort has been made to identify and examine the factors that may contribute to the reduction in traffic congestion by using shared e-scooters.

Keywords: Shared e-scooters, Traffic congestion, UTAUT2 model, Sustainable urban commuting, SEM.

Introduction

Bangalore is known as the *Silicon Valley of India*. It is noted for its technological advancement, economic dynamism, and cultural diversity. However, rapid population growth and a sharp increase in vehicle ownership have resulted in persistent traffic congestion, heightened road safety risks, and growing environmental concerns (Ajit, 2025); (Gupta, 2024). In response to these challenges, urban planners and researchers have increasingly turned their attention toward alternative mobility options, particularly micromobility solutions such as electric scooters, which are often promoted as a means of easing pressure on heavily congested road networks (Nemeslaki, 2023).

Since the mid-2010s, the expansion of shared electric scooter services has been driven by their perceived ability to reduce dependence on private vehicles and address negative externalities, including congestion, air pollution, and noise. Additionally, e-scooters are frequently positioned as effective first- and last-mile connectors that complement existing public transportation systems (Wallgren, 2023). Despite these expectations, empirical evidence regarding their actual contribution to congestion reduction remains mixed. Several studies indicate that electric scooters may replace trips that would otherwise be made on foot or by bicycle, rather than substituting private motorized travel (Asensio, 2022). Against this backdrop, the present review synthesizes existing literature on the influence of electric scooters in shared model on urban traffic conditions, with particular emphasis on developing city contexts such as Bangalore. The objective is to assess whether shared e-scooters meaningfully contribute to congestion mitigation or primarily result in a reconfiguration of travel behaviour (Gupta, 2024) (Mubiru and Westerholt, 2024). Prior research on micromobility suggests that while e-scooters provide a convenient option for short-distance trips, their overall impact on traffic flow is highly context-specific and shaped by factors such as infrastructure quality, usage patterns, and system integration (Kazemzadeh and Sprei, 2022).

Electric moped scooters, in particular, have attracted growing scholarly attention due to their lightweight construction and compact size, which enable greater manoeuvrability in congested urban environments (Liu, 2024). This characteristic allows riders to navigate dense traffic conditions more efficiently than larger vehicles, potentially reducing individual travel delays (Liu, 2024). Nevertheless, questions remain regarding their aggregate effect on urban congestion. Given that e-scooters are predominantly used for short trips, critics argue that they may have limited influence on reducing private automobile usage and, instead, function largely as substitutes for non-motorized modes of transport (Kazemzadeh and Sprei, 2022) (Souza, 2023).

Shared electric scooters have emerged as a relatively sustainable and cost-effective mode of transport, particularly for short-distance travel and for connecting commuters to major public transport nodes (Hélie Moreau, 2020; Kailai Wang, 2023). From the perspective of operational emissions, e-scooters generally perform better than internal combustion engine (ICE) vehicles (Hugo Badia, 2022). However, studies by Poulino et al. (2018) and Hawkins et al. (2013) indicate that the carbon emissions associated with the production phase of electric scooters are comparable to those of conventional vehicles (Ana Filipa Reis, 2023).

Weiss et al. (2015) highlighted that e-bikes—and by extension other micromobility options—are often adopted by individuals who previously relied on walking. This shift raises environmental concerns, as electric micromobility modes depend on electricity generation, which is not entirely carbon-neutral in many regions (Ana Filipa Reis, 2023). Moreau et al. (2020) further argued that a shared e-scooter must remain operational for a minimum of 9.5 months to be considered an environmentally viable mobility solution. Infrastructure quality plays a critical role in achieving this threshold, as smoother pavements and well-maintained sidewalks can significantly reduce wear and tear, thereby extending vehicle lifespan.While shared e-scooters have simplified urban mobility for many users, it is important to acknowledge that their operational ecosystem involves indirect carbon emissions. Activities such as relocating scooters from parking areas to docking points or service locations often rely on fossil-fuel-powered vehicles. Evidence from a survey conducted in Lisbon, Portugal, revealed that frequent vandalism necessitated the daily collection of e-scooters using fuel-powered vans, thereby offsetting some of their environmental benefits (Ana Filipa Reis, 2023). Lisbon was selected as a case study by Fluctuo et al. (2022) due to its high adoption levels, ranking second in Europe in shared e-scooter trips per capita. In Lisbon, e-scooters account for approximately 61% of shared mobility services, compared with 43% in Madrid and 53% in Milan (Rosa Félix, 2023). These findings underline the importance of evaluating shared e-scooters from a holistic sustainability perspective.Mouratidis observed that shared e-scooter users are predominantly residents living closer to city centres and are largely composed of younger male users (Kailai Wang, 2021). These individuals tend to exhibit higher environmental awareness and benefit from good access to public transportation networks (Hugo Badia, 2022; Mouratidis, 2022; Jørgen Aarhaug, 2023). Supporting this observation, a study conducted in Oslo, Norway, reported that the distance traveled by e-scooter users ranged from 0 to 22 kilometers, indicating significant variation in usage patterns (Jørgen Aarhaug, 2023).

User motivation studies reveal that time savings are the most influential factor driving e-scooter adoption, followed by curiosity and cost savings. Among younger users, enjoyment and recreational value were also cited as key motivations for usage (Ricardo Chahine, 2024). A comprehensive assessment conducted in Lisbon found that shared e-scooters contributed to avoiding environmental costs worth approximately €41,000 through reduced emissions of pollutants and greenhouse gases. Additionally, societal benefits linked to increased physical activity were estimated at €657,000. Conversely, increased exposure to air pollution added €143,000 to socio-economic costs, while road accidents significantly elevated costs to nearly €6 million, highlighting the complex trade-offs associated with shared e-scooter systems (Rosa Félix, 2023).

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 36 Issue 1s, 2026, Pages: 1443-1446

Urban congestion remains a defining challenge for metropolitan cities, and modal shifts from four-wheelers to two-wheelers have been widely suggested as a potential mitigation strategy. Smith and Schwieterman (2018) conducted a multimodal analysis of first- and last-mile connectivity in Chicago and identified e-scooters as a cost-effective alternative to traditional public transport for short trips. However, they also noted that e-scooters are unsuitable for longer journeys due to escalating trip costs (Kailai Wang, 2023). Findings from Oslo further suggest that substituting public transport trips with e-scooter usage can reduce travel time by up to 50% (Jørgen Aarhaug, 2023; Hugo Badia, 2022). In contrast, a cross-country European study reported that former car users were more inclined to shift toward shared car services rather than two-wheeled micromobility options (Gustav Bosehans, 2023).

Reck and Axhausen (2021), through surveys conducted in France, Brussels, Atlanta, and Arlington, identified convenience, shorter travel times, and door-to-door flexibility as the primary motivations for adopting e-scooters. In France, shared e-scooter services were actively promoted as complementary feeders to public transport systems (Hugo Badia, 2022).

Research Gaps: Shared electric scooters represent a relatively new and evolving innovation, resulting in notable gaps within existing scholarly literature. Anderson-Hall et al. (2019) observed that although e-scooter usage has expanded rapidly, comprehensive planning strategies integrating micromobility into urban transport systems remain underdeveloped. This disconnects between policy and practice has contributed to user discomfort and operational inefficiencies. Moreover, there is a shortage of empirical studies examining user experience, particularly regarding interactions between e-scooter riders and pedestrians. The concept of Service Level of Service (LOS) has been proposed as a potential framework for bridging the gap between research and practice by quantitatively assessing rider experience. Fishman and Cherry (2016) emphasized the lack of substantive discussion on Scooter Level of Service (SLOS), underscoring the need for further investigation. Several studies have also highlighted the overrepresentation of young, male, and highly educated users in e-scooter adoption, suggesting the need for more inclusive research across diverse demographic groups (Almannaa et al., 2021; Cao et al., 2021; Laa & Leth, 2020; Kazemzadeh, 2022). Additionally, insufficient regulatory clarity and limited policy support have constrained the broader promotion of e-scooters by policymakers (Yujie Guo, 2023). Scholars have called for deeper exploration of sociopsychological factors influencing the adoption and continued use of e-micromobility, particularly across varying cultural and geographical contexts (Bretones & Marquet, 2021; Alexandra Bretones, 2022). Research examining environmental sustainability across the full lifecycle of shared e-scooters also remains limited (Ana Filipa Reis, 2023).

Study Objective: This study seeks to examine how shared e-scooters are influencing the traffic in Bangalore. It investigates key dimensions such as accessibility, convenience, traffic density reduction, private vehicle substitution, environmental sustainability, cost-effectiveness, and weather-related constraints. The research further aims to analyse usage trends, assess impacts on traffic congestion and environmental outcomes, explore integration with public transport systems, examine infrastructure and technological requirements, and understand public perceptions and behavioural shifts. Through this comprehensive approach, the study intends to provide evidence-based recommendations for the effective integration of shared e-scooters into Bangalore's urban transport ecosystem, contributing to the broader objective of developing efficient, sustainable, and liveable cities.

Theoretical Framework: Micromobility encompasses a range of transport modes capable of substituting or supplementing fossil-fuel-based vehicles, thereby mitigating their associated drawbacks (Kazemzadeh, 2022). Shaheen and Cohen (2019) introduced the term "micromobility" to describe shared, low-speed vehicles such as bicycles and scooters, which have gained increasing prominence in recent years (Daniela Arias-Molinares, 2021). Bretones and Marquet (2021) employed mode choice theory to explain how individuals select among different transport alternatives, identifying functional attributes (such as cost, travel time, and convenience) and demographic characteristics (including age, gender, income, and household size) as key latent variables influencing decision-making (Alexandra Bretones, 2022).

Shared e-scooters refer to short-distance electric vehicles designed for brief rental periods (Alberica Domitilla Bozzi, 2021). Since 2017, shared e-scooters have emerged globally as a distinct mobility mode. Shared mobility systems generally include car-sharing, bike-sharing, and scooter-sharing initiatives, with e-scooters forming a central component of micromobility services (Romano Fistola, 2022; Rebecca L. Sanders, 2022). Capsi and Noland (2019) and Shaheen and Cohen (2019) emphasized that micromobility solutions can operate under both shared and privately owned models. Due to their unique characteristics, e-scooters require a specialized analytical framework to adequately capture the riding experience and user behaviour (Kazemzadeh, 2022). Shared e-scooter systems typically operate under three primary models: one-way station-based systems with fixed pickup and drop-off points; free-floating systems that allow flexible parking within designated areas; and peer-to-peer systems in which privately owned scooters are rented out for compensation. Each model presents distinct operational advantages and challenges, particularly in terms of vehicle retrieval, vandalism, and system management (Romano Fistola, 2022; Rebecca L. Sanders, 2022). Based on the literature review and identified gaps, the study formulates specific research objectives and questions.

Data Analysis- CFA

Table 1: CFA- Factor loadings

Factor Loadings					
Factor	Indicator	Estimate	SE	Z	P
AC	AC2	0.132	0.0282	4.68	<.001
	AC4	0.318	0.0294	10.84	<.001
	AC3	0.500	0.0334	14.99	<.001
	AC1	0.233	0.0322	7.26	<.001
CONV	CONV2	0.438	0.0271	16.14	<.001
	CONV3	0.406	0.0257	15.77	<.001
	CONV1	0.456	0.0262	17.42	<.001
COST	COST5	0.591	0.0441	13.41	<.001
	COST3	0.145	0.0284	5.12	<.001
	COST2	0.117	0.0336	3.48	<.001
	COST1	0.258	0.0264	9.77	<.001
WEA	WEA3	0.228	0.0389	5.87	<.001
	WEA2	0.287	0.0447	6.43	<.001
RTC	RTC3	0.390	0.0301	12.95	<.001
	RTC2	0.355	0.0323	10.99	<.001
	RTC1	0.327	0.0308	10.61	<.001

Table 2: Fit indices - CFA

Fit Measures					
				RMSEA 90% CI	
CFI	TLI	SRMR	RMSEA	Lower	Upper
0.926	0.905	0.0379	0.0393	0.0316	0.0469

Data Analysis- SEM

Table 3: Fit indices SEM

User model versus baseline model	
	Model
Comparative Fit Index (CFI)	0.994
Tucker-Lewis Index (TLI)	0.992
Bentler-Bonett Non-normed Fit Index (NNFI)	0.992
Relative Noncentrality Index (RNI)	0.994
Bentler-Bonett Normed Fit Index (NFI)	0.984
Bollen's Relative Fit Index (RFI)	0.980
Bollen's Incremental Fit Index (IFI)	0.994
Parsimony Normed Fit Index (PNFI)	0.771

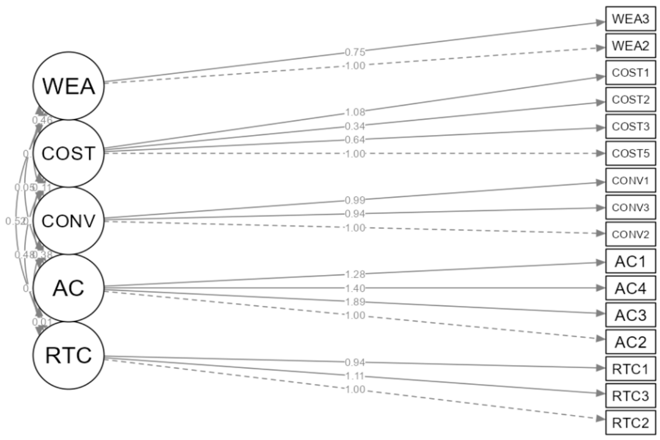
Table 4: Measurement Model SEM

Measurement model								
				95% Confidence Intervals				
Latent	Observed	Estimate	SE	Lower	Upper	β	z	p
RTC	RTC2	1.000	0.0000	1.000	1.000	0.729		
	RTC3	1.110	0.0971	0.920	1.300	0.809	11.43	<.001
	RTC1	0.942	0.0954	0.755	1.129	0.687	9.87	<.001
AC	AC2	1.000	0.0000	1.000	1.000	0.475		
	AC3	1.893	0.2234	1.456	2.331	0.899	8.48	<.001
	AC4	1.401	0.1689	1.070	1.733	0.665	8.29	<.001
	AC1	1.279	0.1510	0.983	1.575	0.607	8.47	<.001
CONV	CONV2	1.000	0.0000	1.000	1.000	0.905		
	CONV3	0.938	0.0263	0.886	0.989	0.849	35.65	<.001
	CONV1	0.990	0.0287	0.933	1.046	0.896	34.43	<.001
COST	COST5	1.000	0.0000	1.000	1.000	0.652		
	COST3	0.643	0.1024	0.442	0.843	0.419	6.28	<.001
	COST2	0.336	0.0899	0.160	0.512	0.219	3.73	<.001
	COST1	1.081	0.0924	0.900	1.262	0.704	11.70	<.001
WEA	WEA2	1.000	0.0000	1.000	1.000	0.709		
	WEA3	0.752	0.0888	0.578	0.926	0.533	8.47	<.001

Table 5: Heterotrait - monotrait (HTMT) ratio of correlations

Heterotrait - monotrait (HTMT) ratio of correlations					
	RTC	AC	CONV	COST	WEA
RTC	1.0000	0.0963	0.0702	0.840	0.949
AC	0.0963	1.0000	0.8509	0.196	0.169
CONV	0.0702	0.8509	1.0000	0.182	0.162
COST	0.8399	0.1964	0.1825	1.000	1.163
WEA	0.9490	0.1694	0.1623	1.163	1.000

Figure 1: Path diagram



Structural Model Interpretation

The structural model was examined to understand the influence of accessibility, convenience, cost-effectiveness, and weather conditions on the reduction of urban traffic congestion. The overall model fit indices indicate an excellent fit (CFI = 0.994, TLI = 0.992, IFI = 0.994), confirming that the model is suitable for interpreting the relationships among the constructs. Based on the estimated path coefficients, **weather conditions emerged as the most influential factor**, showing a strong positive effect on traffic congestion reduction. This finding suggests that favourable weather significantly enhances the usability of electric scooters, thereby contributing to smoother traffic flow in urban areas.

Accessibility demonstrated a positive but relatively weak effect, indicating that while the availability of electric scooters is important, its independent contribution to reducing congestion is limited compared to other factors.

Convenience showed a very minimal impact, with the path coefficient indicating a negligible relationship with congestion reduction. Although the measurement model for convenience was strong (with factor loadings exceeding 0.85), its direct influence in the structural model appears to be limited when other variables are considered simultaneously.

In contrast, **cost-effectiveness exhibited an inconsistent relationship**, with variations observed across different model iterations. This may be attributed to weaker factor loadings for some cost-related indicators (e.g., COST2 and COST3) and possible overlap with other constructs, as also reflected in the HTMT results (COST–WEA = 1.163).

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 36 Issue 1s, 2026, Pages: 1443-1446

The discriminant validity assessment further highlights that **weather conditions and cost-effectiveness are highly correlated**, exceeding acceptable HTMT thresholds, which indicates that respondents may perceive these constructs as closely related. Similarly, the relationship between weather conditions and traffic congestion reduction is also relatively high (HTMT = 0.949), suggesting some conceptual overlap.

Overall, the results indicate that **environmental factors, particularly weather conditions, play a dominant role** in influencing the effectiveness of electric scooters in reducing traffic congestion. While accessibility and convenience contribute to the model, their effects are comparatively modest. The findings also point to the need for clearer differentiation between cost and weather-related constructs in future research.

Model Fit Assessment

The results indicate that the proposed structural model fits the observed data very well. The goodness-of-fit indices were found to be above the commonly recommended levels. The Comparative Fit Index (CFI = 0.994), Tucker–Lewis Index (TLI = 0.992), Incremental Fit Index (IFI = 0.994), and Normed Fit Index (NFI = 0.984) all suggest that the model provides a strong representation of the relationships among the variables included in the study. In addition, the Parsimony Normed Fit Index (PNFI = 0.771) indicates that the model maintains an acceptable level of simplicity while still explaining the data effectively.

Measurement Model Evaluation

Confirmatory factor analysis was conducted to assess the measurement model and to determine whether the observed indicators adequately represent their respective latent constructs. The results show that all measurement items were statistically significant, with p-values below 0.001. This suggests that the indicators meaningfully contribute to measuring the constructs included in the study. A number of items demonstrated satisfactory standardized loadings, indicating that the variables capture the underlying concepts effectively.In particular, the indicators associated with **convenience** showed relatively strong loadings, suggesting that respondents clearly perceived and understood this construct. The indicators related to **accessibility** also showed acceptable loadings, with some items contributing more strongly than others. Similarly, the items measuring **reduction in traffic congestion** displayed consistent and reliable contributions to the construct. However, certain indicators under the **cost** and **weather** constructs showed comparatively lower loadings. Although these items were statistically significant, their contribution to the construct was relatively weaker compared to other variables in the model.

Discriminant Validity Assessment

Discriminant validity was examined using the Heterotrait–Monotrait (HTMT) ratio of correlations. This analysis helps determine whether the constructs included in the model are sufficiently distinct from one another. The results show that several construct pairs fall within acceptable limits, indicating that they measure different conceptual dimensions. For example, the relationships between accessibility and cost, as well as between convenience and cost, show relatively low HTMT values, suggesting that these constructs are clearly distinguishable.At the same time, some relationships appear to be relatively high. In particular, the association between **weather conditions and cost** exceeds the commonly accepted threshold. Similarly, the relationship between **weather conditions and reduction in traffic congestion** is also quite strong. These findings suggest that respondents may perceive certain similarities between these constructs.This overlap may arise from the way respondents interpret the influence of weather conditions on the cost and usability of electric scooters, which could lead to closely related responses across these variables.

Conclusions

The findings provide empirical support for the overall structure of the proposed model. The analysis confirms that the selected constructs are relevant for understanding the role of electric scooters in addressing urban traffic congestion. While the results highlight generally strong measurement properties and model fit, some overlap between specific constructs suggests the need for minor improvements in measurement design.Despite these limitations, the model offers meaningful insights into the factors that influence the effectiveness and adoption of electric scooters in urban transportation systems.

References

Ajit. (2025). Sustainable Mobility: Integration Models, Smart Traffic Management and Last Mile Connectivity in Bangalore Urban. *IJISRT*.

Asensio. (2022). Impacts of micromobility on car displacement with evidence from a natural experiment and geofencing policy. *nature energy*.

Bentler, P. M. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *APA PsychNet*, 588-606.

Budimir, A. B. (2024). Understanding the Adoption Dynamics of ChatGPT among Generation Z: Insights from a Modified UTAUT2 Model. *Journal of theoritical and applies electronic commerce research*.

Cameron, J. M. (2010). The Application of Mixed Methods in Organisational Research: A Literature Review. *The Electronic Journal of Business Research Methods*, 95-105.

Cheung, G. W. (2017). Current Approaches for Assessing Convergent and Discriminant Validity with SEM: Issues and Solutions. *Academy of management*.

Chou, C. &. (1995). Estimates and tests in structural equation modeling. *Amarican psychological association*.

Clark, J. W. (2007). *Designing and Conducting Mixed Methods Research* . California: Sage.

Creswell, J. W. (2014). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (4th ed.). *SAGE Publications*.

Cristian Vidal-Silva a, ∗. A.-O.-M. (2024). Social influence, performance expectancy, and price value as determinants of telemedicine services acceptance in Chile. *Heliyon*.

Daire Hooper, J. C. (2008). Structural Equation Modelling: Guidelines for Determining Model Fit. *Arrow@TU Dublin*.

Gupta. (2024). An Overview of the Effect of Rising Traffic and Congestion in Bangalore on the Lives of General Public . *International Journal for Research in Applied Science & Engineering Technology (IJRASET)* .

Liu. (2024). Perception, travel satisfaction associated with the use of electric mopedscooters: Evidence from Suzhou, China. *Research Square*.

Nemeslaki, S. a. (2023). The Implications of Electric Scooters as a New Technology Artifact in Urban Transportation . *Acta Polytechnica Hungarica*.

Kevin D. Carlson, A. O. (2010). Understanding the Impact of Convergent Validity on Research Results. *Organizational Research Methods*.

Kriti Priya Gupta, R. M. (2019). Factors influencing adoption of payments banks by Indian customers: extending UTAUT with perceived credibility. *Journal of Asia Business studies*.

Kuttimani Tamilmani, N. P. (2017). A Systematic Review of Citations of UTAUT2 Article and Its Usage Trends. *Digital Nations – Smart Cities, Innovation, and Sustainability* , 38-49.

Kuttimani Tamilmani, N. P. (2020). Consumer Acceptance and Use of Information Technology: A Meta-Analytic Evaluation of UTAUT2. *Information Systems Frontiers*.

Kuttimani Tamilmani, N. P. (2021). The extended Unified Theory of Acceptance and Use of Technology (UTAUT2): A systematic literature review and theory evaluation . *International Journal of Information Management*.

M R Ab Hamid, W. S. (2017). Discriminant Validity Assessment: Use of Fornell & Larcker criterion versus HTMT Criterion. *Journal of Physics: Conference Series*.

María García de Blanes Sebastián, A. A. (2023). What are the leading factors for using Spanish peer-to-peer mobile payment platform Bizum? The applied analysis of the UTAUT2 model. *Technological Forecasting and Social Change*.

Marialisa Nigro, M. C. (2022). Investigating Potential Electric Micromobility Demand in the city of Rome, Italy. *Transportation research- Procedia*.

Souza. (2023). (Micro)mobility by electric scooters: psychometric assessment of the importance of built environment attributes to mode choice in Belo Horizonte . *Transportses*.

Sprei, K. a. (2022). Towards an electric scooter level of service: A review and framework. *Travel Behaviour and Society*.

Wallgren. (2023). Comparing the bad media-fuelled reputation of e-scooters with real-life user and non-user perceptions: Evidence from Sweden . *Transportation Research Part F: Psychology and Behaviour* .

Westerholt, M. a. (2024). A scoping review on the conceptualisation and impacts of new mobility services. *European Transport Research Review*.