

SUSTAINABILITY OF SHARED MOBILITY: RECENT EMPIRICAL EVIDENCE

Lucia Rotaris¹, Chiara Ricchetti¹,
Luciano Agustin Pana Tronca¹,
John Kebari Omwamba¹

ABSTRACT

As the world becomes more urbanized, the challenges facing cities increase, making them more vulnerable to the effects of climate change, to which the transport sector is a major contributor. Despite progress in making private vehicles more sustainable and efficient, a radical change in travel behavior remains essential. One of the most promising solutions is carpooling. The aim of this paper is to highlight the factors that favor the uptake of this form of mobility, including socio-economic characteristics and individual attitudes, and to describe the economic, social and environmental impacts of carpooling. It also analyses the barriers to its diffusion and the policies that support its uptake. Shared mobility, such as carpooling, has the potential to play a critical role in promoting social inclusion by offering affordable transportation options to underserved communities and contributing to a just transition toward a more sustainable and equitable urban transport system.

KEYWORDS

Carpooling; shared mobility; environmental impact; social inclusion

¹ Department of Economic, Business, Mathematical and Statistical Sciences, University of Trieste.

1. INTRODUCTION

People commute from rural to urban areas where global (climate change, heat island effects, extreme weather effects such as floods, droughts and heatwaves) and local (air pollution, noise) externalities from transport are more intense and damaging. In Italy, the proportion of the population residing in urban areas has reached almost 70% (www.istat.it/storage/ASI/2022/Sintesi.pdf). This figure is set to rise further, accompanied by an expansion of the urban footprint. In fact, Italy is the most vulnerable of the major European economies to the effects of climate change. According to the Macroeconomic Climate Stress Test estimated by the Scope Ratings agency¹, the impact of the physical risks associated with extreme temperatures, river floods and droughts, as well as the costs of the energy and environmental transition to reduce greenhouse gas emissions, could amount to EUR 17.5 trillion for Italy between 2020 and 2050, equivalent to 14.5% of GDP. As highlighted by Spano et al. (2020), the intensification of extreme climate phenomena, particularly heat waves and intense rainfall, serve as the primary amplifiers of climate risk factors in urban areas. In Italy, the probability of risk from extreme events has increased by 9% over the past two decades, and urban areas experience temperatures that are 5-10°C higher than their surrounding rural areas. Furthermore, in Italy in 2021, almost 47,000 people died prematurely due to exposure to PM2.5, one of the primary sources of which is road transport (www.ambientenon-solo.com). According to the Italian Society of Environmental Medicine Italy is the first country in Europe for deaths attributable to air pollution with approximately 80,000 premature deaths per year (www.ansa.it).

Technology can help reducing the environmental impact of transport, since new vehicles are more energy efficient and less polluting, but it is not enough. A change in behaviour is needed to make more efficient use of the existing car fleet. Indeed, according to Eurostat, Italy has the highest car ownership rate in Europe, with an average of 684 cars per 1,000 inhabitants. The Unione Nazionale Rappresentanti Autoveicoli Esteri estimates that the average age of the car fleet in Italy is over 14 years and is therefore highly polluting (www.unrae.it). The excessive number of cars on limited, congested road networks, especially in urban areas, causes congestion and traffic jams. In fact, according to Parclick, Europe's leading parking reservation company with over one million active users, Italians spend an average of 30 minutes a day looking for a parking space. Drivers in Italy spend more time in traffic jams than drivers in most other European countries. In fact, they spend an average of 37 hours a year in traffic jams (www.transport.ec.europa.eu). In addition, cars are only used for 6% of their lives, making their use highly inefficient.

Sharing the huge fleet of private cars available in Italy would significantly increase the efficiency of the transport system. Shared mobility can be divided into

¹ www.scoperatings.com

two main categories: the sharing of a passenger journey between private individuals without a profit motive, e.g. carpooling and vanpooling, and the sharing of a vehicle owned by an operator for profit, e.g. cars, motorcycles, bicycles and scooters. The aim of this research is to shed light on carpooling, which is the less studied of the two types of shared mobility, accounting for only 5% of commuting trips in Italy (www.dati.istat.it).

In Italy, there is an almost complete lack of data on the use of carpooling to commute to work. The only data available is published by the Sharing Mobility Observatory, but it is limited to operators directly contacted by the Observatory and does not provide a complete picture of the phenomenon at national level (www.osservatoriosharingmobility.it). The Observatory's data for 2023 show the extent to which the Covid-19 pandemic has affected the company carpooling segment, with a sharp drop in the number of trips in 2020 and no signs of recovery in 2021. It is only in 2022 that there are signs of recovery, with 97,000 trips in the first half of the year, compared to 103,000 for the whole of 2021. In Italy, there are three main platforms offering transport to and from work: JoJob, with partnerships with 242 large Italian companies, UP2GO, with partnerships with 22 companies, and BePooler, with partnerships with 35 companies. In 2019, the number of subscribers increased by about $\frac{1}{4}$ compared to the previous year, exceeding 350,000 workers, 83% of which were managed by the operator JoJob. Of the total number of subscribers in 2019, 95% were registered as corporate subscribers, highlighting the difficulty of attracting users from outside the 'corporate community'. The average distance travelled in 2019 was 28.3 km, compared to less than 20 km in 2018, with more than 50% of trips lasting between 11 and 60 minutes.

Given the alleged potential of carpooling to reduce the negative externalities of road transport, promote social inclusion and increase the efficiency of the transport system, this study aims to describe this form of shared mobility and the characteristics of the people who use it (section 2). Section 3 focuses on the environmental, economic and social impacts of carpooling as emerging from the most recent scientific literature. Section 4 describes the factors that favor the uptake of carpooling and the best practices documented in the literature. Section 5 analyses the barriers to carpooling and highlights the open questions. Section 6 concludes by summarizing the main potentialities and critical features of this form of shared mobility, suggesting transport policies that should be implemented to support its uptake and describing future lines of research.

2. DEFINITION OF CARPOOLING AND USERS' CHARACTERISTICS

The term 'carpooling' is used to describe the practice of sharing a vehicle between individuals with similar origin-destination pairs, and it works as a partnership between riders and drivers that are usually co-workers or neighbors (Shaheen et al.,

2018). The parties agree to share the use of a private vehicle for the same trip at a mutually convenient time. It is distinct from ride-hailing, where individuals pay for a ride from a professional or part-time driver through an app such as Uber or BlaBlaCar. In fact, in carpooling, the driver is not a professional but a private individual who agrees to share the journey (or part of it) for free or in exchange for a contribution to the cost of the journey (Aguilera and Pigalle, 2021; Dinesh et al., 2021; Echeverría et al., 2021; Xiao et al., 2024). In ride-hailing, instead, platforms allow the rider to hire the driver for on-demand trips. The issue of carpooling for work, as opposed to leisure or shopping, has received more attention in the academic literature. This is because work-related travel is more frequent and has fixed departure and arrival points, making it a relatively simpler logistical problem to address.

Carpooling to work, which is the most widely studied, partly due to its potential public benefits, is often associated with men who are employed full-time with a fixed schedule and have access to a vehicle for work-related purposes (Gheorghiu and Delhomme, 2018). Also Anthopoulos and Tzimos (2021), in their recent literature review on carpooling platforms, found that men tend to use carpooling services more frequently than women, and that younger individuals and those with lower levels of education are more likely to carpool. In a recent survey conducted in Jordan, Al-Masaeid and Al Olaimat (2023) found that male young individuals were more likely to express a willingness to carpool. The authors suggest that this is because women attach greater importance to factors such as convenience, privacy and trust. In their analysis of the factors influencing the willingness to participate in a carpooling system at the Universidad de los Andes in Bogotá, Colombia, Simancas et al. (2024) identified two key factors influencing drivers' decisions: distance (living further away from campus is a significant predictor of carpooling) and age (being young). In contrast, passengers' choices are influenced by gender (women are more likely to seek rides as passengers) and income level (higher income individuals are less likely to engage in any form of carpooling). Therefore, according to the empirical evidence emerging from the literature, being male tends to favour carpooling. However, in their cross-country analysis of all types of carpoolers, Molina et al. (2020) find that in Italy, individuals who are female, older, less educated, married, have children and are not full-time employees are more likely to carpool. This finding is likely to be due to the primary caring role that women continue to play in Italy compared to other countries.

Neoh et al. (2017) conducted a meta-analysis to determine which factors favour carpooling. Among the situational factors they examined, they found that the scale of the employer has the largest positive impact, followed by travel costs, employees' fixed (regular) work schedule, and living in an urban area. Si et al. (2023) also find that people living in more densely populated areas, where there are more opportunities for matching trips, are more likely to carpool than people living in other areas.

The main factors that individuals consider when deciding whether to use carpooling are cost savings and the reliability of carpoolers' schedules (Gheorghiu

and Delhomme, 2018). Indeed, carpooling offers a range of ‘private’ benefits to users, including shared travel costs, reduced stress and often preferential parking. According to Al-Masaeid and Al Olaimat (2023), the provision of private parking spaces would double the number of people willing to adopt carpooling. The potential to save time is another important factor that attracts commuters to ridesharing. When carpooling, passengers do not have to wait for public transport to arrive, which is subject to fixed timetables. In addition, riders can use High Occupancy Vehicle (HOV) lanes, where available, to travel faster (Si et al., 2023). Conversely, the perceived benefits of travelling by public transport are negatively correlated with the frequency of carpooling (Gheorghiu and Delhomme, 2018).

In addition, carpooling offers perceived ‘public’ benefits, including the reduction of fuel consumption, which is a non-renewable resource, and therefore the reduction of CO₂ emissions, air pollution and environmental damage. In fact, the second most frequently cited reason for choosing carpooling is the perceived improved environmental sustainability of this mode of transport. In addition, carpooling is perceived as contributing to the reduction of traffic congestion and of public space for parking (Molina et al., 2020). Simancas et al. (2024) find a positive correlation between environmental concern and pro-environmental attitude, enjoyment of walking and cycling, and willingness to offer one’s car for carpooling as a driver. Conversely, the belief that individuals should be allowed to use their vehicles as often as they wish, combined with a fear of using public transport and a preference for commuting by car, have a significant positive influence on the decision to carpool as a passenger. Tsai et al. (2021) also find that, in addition to enjoyment and economic benefits, sustainability has a significant positive effect on the perceived value of carpooling, which in turn has a positive effect on the intention to use it.

Psychological and attitudinal factors also play an important role. The frequency of carpooling is found to be significantly and positively correlated with peer effects (e.g. ‘My friends and colleagues carpool’, ‘My family carpool’) and the number of kilometres travelled per year. Pigalle and Aguiléra (2023), based on an online survey conducted in 2016 with a sample of 2,000 French adults, find that carpoolers are significantly influenced by peer effects in their choice of travel mode. In fact, they have a much higher percentage of people in their environment who practice carpooling. They also find that long-distance carpoolers rely more on platforms and apps than on institutional and informal networks, and have higher levels of trust than other groups of carpoolers.

Dinesh et al. (2021) identify value beliefs as the primary motivator for ridesharing behaviour, including self-transcendence, openness to change and self-enhancement. Si et al. (2023) find that many additional psychological factors influence the willingness to carpool, including positive attitudes towards new technologies, trust in the service built through information sharing between passengers and drivers, psychological comfort of travelling as a passenger, spending time with like-minded

people, making friends, building a good personal image, and altruism. In addition, Si et al. (2022), analysing data from 1056 carpoolers in China, find that attitudes (e.g. the perception that carpooling is a sensible, prudent and beneficial choice for both passengers and drivers) and subjective norms (e.g. the influence of friends and family members who use carpooling, the recommendation of a trusted person, and the perception that significant others support the practice) are significant predictors of the intention to engage in carpooling. The authors also find that perceived behavioural control (e.g., believing that using carpooling services is easy, that there is sufficient time and energy to use these services, and that the decision to use carpooling is ultimately up to the individual) is an additional key factor influencing intention to carpool. Finally, the use of carpooling is encouraged by the fact that society and public opinion are in favour of environmental protection and low-carbon travel. In a survey of 392 people in Hefei, China, Kang et al. (2024) find that commuters' intention to carpool was positively influenced by perceived usefulness, social influence and environmental awareness, and negatively influenced by perceived risk. Al-Masaeid and Al Olaimat (2023), on the other hand, find that the main barriers to carpooling in Jordan are the perceived lack of privacy, safety and trust. Indeed, a carpool trip provides an ideal setting for social interaction, as highlighted by Anthopoulos and Tzimos (2021). However, lack of trust remains a significant barrier to carpooling, particularly for women.

3. ENVIRONMENTAL, ECONOMIC AND SOCIAL IMPACT

The practice of carpooling has the potential to reduce the number of vehicles on the road, thereby reducing CO₂ emissions. Liu et al (2020) estimated that 38.2% of trips made in Greater London could be successfully converted to carpooling, resulting in a carbon reduction rate of 19.4%. A study by Bruck et al. (2017) examined the potential impact of carpooling on the commuting of 135 employees of the Santa Maria Nuova hospital in Reggio Emilia, Italy. The authors conclude that the implementation of carpooling strategies could lead to a reduction in CO₂ emissions. Specifically, the 2-way grouping strategy, in which employees use the same carpool for both their outward and return journeys, has the potential to reduce emissions by around 22%. In contrast, the 1-way grouping strategy, which allows employees to use different carpools for each trip, could increase the reduction potential to around 28%. A study by Tomás et al. (2021) investigated the impact of implementing carpooling on three campuses of the University of Aveiro (Portugal). The results showed that the use of carpooling for groups of up to three people commuting from home to the university campus could lead to a 5% reduction in carbon dioxide emissions and a 7% reduction in nitrogen oxides. It was also estimated that average speed could increase by 7% and travel time could be reduced by 8%. In the most comprehensive review of the literature on the environmental

impact of shared mobility, Arbeláez Vélez (2024) identifies a significant reduction when carpooling is used, not only in terms of CO₂ and greenhouse gases, but also in terms of NO_x, PM₁₀, CH₄, ozone depletion, energy consumption and land use.

Yin et al. (2018) estimate the impact of several ridesharing scenarios for 2030, applied to the Paris region. Contrary to their expectation that a 50% increase in car occupancy would reduce CO₂ emissions by 33%, distance and relocation effects end up dividing the emission reduction by a factor of 2 to 3, depending on the time of day considered. Moreover, some studies have shown that carpooling may not be a direct substitute for private car use, but rather a substitute for public transport (Aguilera and Pigalle, 2021). Si et al. (2023) also find that the majority of passengers are not regular car users but public transport users. However, Anthopoulos and Tzimos (2021) conclude that although carpooling is seen as a substitute for public transport, numerous studies indicate that integrating public transport with carpooling would improve accessibility, social inclusion, access to work place, and to educational services, especially in suburban areas where public transport is scarce.

The economic impact of carpooling is rarely addressed in the literature. Liu et al. (2020) estimate that carpooling reduces total trip costs by 21%, with riders saving slightly less than drivers. In their 2018 study, Shaheen et al. (2018) highlight the significant reduction in the need for parking, citing capital cost savings of between \$15,000 and \$45,000 and annual operating costs of around \$360 to \$2,000 per parking space. A study by Mou et al. (2020) in China examined the impact of carpooling on the purchase intentions of potential car buyers. The results showed that 22% of potential car buyers postponed their purchase plans, while 12% ultimately decided not to purchase a vehicle. Notably, individuals with lower incomes or those working in central urban areas were more likely to avoid or postpone their purchase plans.

Bastos et al. (2021) identify an important socially relevant outcome of carpooling. The study shows that carpooling drivers adopt safer driving behaviours, including reduced speeding and mobile phone use, compared to non-carpooling drivers. Carpooling therefore has the potential to reduce the number of road accidents. The analysis is based on data from the Brazilian Naturalistic Driving Study, which included 108 carpooling trips covering 40.45 hours and 895.87 km.

The social dimensions of carpooling, in particular accessibility, social cohesion and racial discrimination, remain under-researched. Shaheen et al. (2018) mention that carpooling particularly benefits low-income and minority households, as they are more likely to live near major highways and highly congested road networks, and are disproportionately affected by vehicle emissions. They also found that carpooling can provide access to jobs for lower-income households and those with more workers than vehicles. Similarly, analysing US county-level data for 2017, Benita (2020) found that declines in car ownership and income levels led to the largest increases in workers carpooling to work. In addition, Anthopoulos and Tzimos (2021) find that those with lower incomes are more likely to carpool. Si et al.

(2023) estimated that immigrants and those without access to a car are more likely to use carpooling services. Xu and Zhang (2022) used data from the American Community Survey to examine the use of carpooling by immigrants and found that lower levels of English proficiency were associated with higher odds of carpooling and larger carpooling networks.

4. FACTORS FAVORING THE UPTAKE AND BEST PRACTICES

The increasing use of collaborative consumption platforms in many areas of daily life could facilitate their use for sharing short or long distance journeys. In addition, some authors believe that the growth of remote working will lead to an increase in carpooling, as there will be fewer commuting trips and fewer organisational constraints. Furthermore, the rapid development and adoption of two-sided platforms and apps such as AirB&B, the potential to integrate carpooling as an additional mobility option through MaaS platforms, and the growing influence of social media in shaping opinions and social norms are seen as key drivers of carpooling use (Aguilera and Pigalle, 2021). In this vein, Yi et al. (2022) investigate the impact of information asymmetries, or psychological costs, on commuters' mode choice and the distribution of carpooling demand. The study uses data from ten platforms in Ningbo City, China. The authors show that the use of mobile internet has led to an increase in the probability that drivers and passengers are willing to carpool, from 19% and 15% to 28% and 20%, respectively. The authors demonstrate that both the average pick-up distance and the average waiting time for passengers have decreased as a result of the use of mobile internet and matching platforms.

In the only natural experiment documented in the literature on the impact of fiscal policies to encourage carpooling, Wang and Monchambert (2024) found that carpooling subsidies introduced by some local authorities in France since 2019 led to a 5.5-fold increase in the number of monthly short-distance carpool trips. This impact was found to increase over time, with greater magnitude observed in more densely populated areas. Cohen et al. (2022) instead report that the introduction of three HOV lanes in Israel in 2019 has led to an increase in carpooling, with new users joining the platform and drivers sending more carpool offers. This had a positive impact on both the use of HOV lanes and the carpooling market, with an increase in carpooling on non-HOV routes as well.

5. BARRIERS AND OPEN QUESTIONS

Several factors prevent greater and more widespread carpooling. The characteristics of low-density areas present a unique set of challenges, particularly when compared to urban areas. This is due to a number of factors, including the average distances travelled, the prevalence of car ownership and the extent of car use (Aguilera

and Pigalle, 2021). In addition, the practice of carpooling has been found to result in a longer total travel time than for individuals travelling alone. Liu et al. (2020) estimate that the increase in travel time for drivers is 27.5%. In order to ensure social fairness, it is essential to adjust the fare sharing between drivers and riders according to a cost-based dynamic pricing model. Rey-Merchán et al. (2022) surveyed a group of panelists to assess the advantages and disadvantages of carpooling for teachers. They found that increased travel time and loss of personal independence were the most important barriers, particularly for short commuting distances.

One of the main concerns for carpoolers is the risk of missing the return journey. This highlights a key issue for policy makers and businesses seeking to increase the uptake of carpooling, which is to provide reliable alternatives for carpoolers in the event of unexpected circumstances. Molina et al. (2020) note that the unpredictability of travel patterns is the main factor hindering the widespread adoption of carpooling as a commuting strategy among workers.

In addition, Si et al. (2023) identify several negative psychological factors that inhibit the use of carpooling. These include reluctance to be disturbed by others, racial discrimination, unfavorable carpooling experiences, concerns about potential misuse of personal information, fear of traffic accidents, previous involvement in carpooling safety incidents, and fear of sexual harassment.

Finally, as highlighted by Rijavec et al. (2020), the availability of designated places to pick up and drop off passengers remains a significant challenge for carpool users. A field survey of car parks near motorway junctions found that 60% of respondents would be willing to leave their car and carpool if the necessary facilities were available.

6. POLICIES TO PROMOTE CARPOOLING

The literature on carpooling that we have reviewed has shown how this form of shared mobility can significantly reduce the negative externalities of road transport by reducing environmental impacts, generalized transport costs and social marginalization. Transport policy plays a crucial role in encouraging carpooling. Liu et al. (2020) present a range of fiscal measures to encourage carpooling. These include parking discounts for carpoolers (or parking surcharges for single-occupancy vehicles), congestion charge exemptions, and travel subsidies for carpooling trips. However, given that those who use carpooling already perceive it as a cost-effective mode of transport, it would be advisable for policy makers and private companies that do not have the resources to fund carpooling to simply promote this information to attract new users. Also, according to Si et al. (2022), it is more effective to show users the many benefits of carpooling including time savings for passengers, labor savings, financial savings and convenience, rather than subsidizing it. In a recent literature review, Anthopoulos and Tzimos (2021) highlighted that increasing

the cost of single-occupancy vehicles through the introduction of road pricing and parking charges is a more effective strategy than subsidizing carpooling. The same result is found by Liu et al. (2020). However, they also note that this approach may face political challenges. Franckx (2024) estimates that in Belgium a road user charge of 4 euro cents per km combined with a carpooling subsidy, which reduces variable general costs by almost 50%, can increase the occupancy rate to 1.5.

Command and control measures include the introduction of HOV lanes, dedicated restricted traffic zones and parking areas, and the provision of tailored travel information by carpooling and other mobility service platforms. Ray and Khedira (2023) propose the use of instant carpooling on road sections where critical mass is reached, using physical roadside variable message signs. They report positive results in the Lyon area, where carpooling has been significantly increased at low marginal cost. However, they point out that this policy needs to be carefully designed to ensure that the carpooling routes are consistent with and complementary to existing public transport services.

Given the positive attitudes of carpoolers towards public transport, there is an opportunity for policy makers to integrate carpooling with public transport through special fares and MaaS platforms. This would increase the flexibility of both modes and reduce waiting times. However, Cellina et al. (2024), who study the perceptions of users of a Swiss-based MaaS platform, find three practical conditions that may hinder the effectiveness of MaaS platforms in leveraging carpooling. The first barrier they find is that integrating carpooling into intermodal trips increases the number of interchanges potentially affected by delays. The second barrier is the need to build trust between strangers, which requires a trade-off between strict identity checks and fast registration. The third barrier is the perceived lack of safety when using carpool pick-up and drop-off points such as bus stops. They therefore suggest rewarding participants with vouchers from public institutions, or virtual gamification and feedback on emissions saved.

A fourth set of measures could be based on the adoption of more effective communication campaigns promoting the multiple benefits of carpooling. In this respect, it would be beneficial to disseminate information on the advantages of carpooling over driving alone through various media channels. Furthermore, as the literature has shown that carpooling is strongly influenced by attitudes and beliefs, it may be effective to use nudges to encourage carpooling. In this sense, Gessner et al. (2024) use a field experiment with 341 employees of a large German company to investigate whether nudges (social comparisons and a climate-related moral appeal) can promote sustainable travel. However, they find that only the simultaneous application of both nudges is effective and that the positive result disappears in the second half of the treatment period. Therefore, nudges and promotional campaigns should be carefully designed to be effective and to see a sustained shift of individuals from driving alone to carpooling. Finally, it is imper-

ative that regulators and platforms strengthen security measures to protect passengers' private information.

Last but not least, it is crucial to regularly collect data on who, why and how car-poolers actually use this form of shared mobility. In Italy, 5% of the population aged 15 and over travel by car as passengers, but we do not know whether this is within the family or with third parties. There is no observatory for carpooling. In the absence of data, it is difficult to understand how to promote this practice, what policies work, and how to intervene to induce a significant and permanent modal shift.

7. CONCLUSION

The future of carpooling in Italy and Europe appears promising, driven by increasing concerns about sustainability, urban congestion, and climate change. As cities continue to grapple with these challenges, carpooling has the potential to reduce traffic, lower emissions, and improve air quality, contributing to a more sustainable urban transport system. Moreover, carpooling can foster social inclusion by providing affordable transport options to individuals who may have limited access to private vehicles, particularly in underserved areas.

However, the widespread adoption of carpooling faces several barriers. Lack of interest from individuals, often due to a preference for personal convenience and privacy, remains a significant challenge. In addition, the absence of coordinated policies and incentives to promote carpooling—such as dedicated lanes, subsidies, or tax benefits—limits its growth potential. To unlock the full benefits of carpooling, it will be essential for policymakers to create an enabling environment, which includes awareness campaigns, infrastructure improvements, and financial incentives to encourage greater participation among individuals.

In conclusion, while carpooling holds great potential to enhance sustainability and inclusivity in urban areas, its success depends on overcoming the key barriers of personal preferences and the need for targeted policies and incentives.

FUNDING

This study was funded by the European Union—NextGenerationEU, within the GRINS (Growing Resilient, INclusive and Sustainable) research framework and the 3S_MobS (Sustainable, Shared and Smart Mobility Solutions) project (PE00000018, CUP H93C22000650001). The opinions and conclusions expressed in this publication are those of the authors and do not necessarily reflect the views of the European Union. The European Union is not responsible for any use that may be made of the information contained herein.

BIBLIOGRAPHY

- Aguilera, A., & Pigalle, E. (2021). The future and sustainability of carpooling practices. An identification of research challenges. *Sustainability*, 13(21), 1-16, 11824.
- Al-Masaeid, H. R., & Al Oلمات, G. A. (2023). Modeling Determinants of Carpooling Intentions in Jordan. *Transportation Research Record*, 2677(3), 797-819. <https://doi.org/10.1177/03611981221117819>
- Anthopoulos, L. G., & Tzimos, D. N. (2021). Carpooling platforms as smart city projects: A bibliometric analysis and systematic literature review. *Sustainability*, 13(19), 1-29, 10680.
- Arbeláez Vélez, A. M. (2024). Environmental impacts of shared mobility: a systematic literature review of life-cycle assessments focusing on car sharing, carpooling, bikesharing, scooters and moped sharing. *Transport reviews*, 44(3), 634-658. <https://doi.org/10.1080/01441647.2023.2259104>
- Bastos, J. T., Dos Santos, P. A. B., Amancio, E. C., Gadda, T. M. C., Ramalho, J. A., King, M. J., & Oviedo-Trespalacios, O. (2021). Is organized carpooling safer? Speeding and distracted driving behaviors from a naturalistic driving study in Brazil. *Accident Analysis & Prevention*, 152, 1-10, 105992.
- Benita, F. (2020). Carpool to work: Determinants at the county-level in the United States. *Journal of Transport Geography*, 87, 1-10, 102791.
- Bruck, B. P., Incerti, V., Iori, M., & Vignoli, M. (2017). Minimizing CO2 emissions in a practical daily carpooling problem. *Computers & Operations Research*, 81, 40-50. <https://doi.org/10.1016/j.cor.2016.12.003>
- Cellina, F., Derboni, M., Giuffrida, V., Tomic, U., & Hoerler, R. (2024). Trust me if you can: Practical challenges affecting the integration of carpooling in Mobility-as-a-Service platforms. *Travel Behaviour and Society*, 37, 1-10, 100832.
- Cohen, M. C., Jacquillat, A., Ratzon, A., & Sasson, R. (2022). The impact of high-occupancy vehicle lanes on carpooling. *Transportation research part A: policy and practice*, 165, 186-206. <https://doi.org/10.1016/j.tra.2022.08.021>
- Dinesh, S., Rejikumar, G., & Sisodia, G. S. (2021). An empirical investigation into carpooling behaviour for sustainability. *Transportation research part F: traffic psychology and behaviour*, 77, 181-196. <https://doi.org/10.1016/j.trf.2021.01.005>
- Echeverría, L., Giménez-Nadal, J. I., & Molina, J. A. (2021). Carpooling: User profiles and well-being. IZA Discussion Papers, No. 14736, Institute of Labor Economics (IZA), Bonn.
- Franckx, L. (2024). Increasing the occupancy rates of cars: Carrot, stick or both?. *Case Studies on Transport Policy*, 15, 1-18, 101132.
- Gessner, J., Habla, W., & Wagner, U. J. (2024). Can social comparisons and moral appeals encourage low-emission transport use?. *Transportation Research Part D: Transport and Environment*, 133, 1-20, 104289.
- Gheorghiu, A. & Delhomme, P. (2018). For which types of trips do French drivers carpool? Motivations underlying carpooling for different types of trips. *Transportation Research Part A: Policy and Practice*, 113, 460-475. <https://doi.org/10.1016/j.tra.2018.05.002>

- Kang, W., Wang, Q., Cheng, L., & Ning, M. (2024). Examining Commuters' Intention to Use App-Based Carpooling: Insights from the Technology Acceptance Model. *Sustainability*, 16(14), 1-17, 5894.
- Liu, X., Titheridge, H., Yan, X., Wang, R., Tan, W., Chen, D., & Zhang, J. (2020). A passenger-to-driver matching model for commuter carpooling: Case study and sensitivity analysis. *Transportation Research Part C: Emerging Technologies*, 117, 1-21, 102702.
- Molina, J. A., Giménez-Nadal, J. I., & Velilla, J. (2020). Sustainable commuting: Results from a social approach and international evidence on carpooling. *Sustainability*, 12(22), 1-12, 9587.
- Mou, Z., Liang, W., Chen, Y., Zhang, H., Yan, K., & Li, X. (2020). The effects of carpooling on potential car Buyers' purchasing Intention: A case study of Jinan. *Case Studies on Transport Policy*, 8(4), 1285-1294. <https://doi.org/10.1016/j.cstp.2020.08.008>
- Neoh, J. G., Chipulu, M., & Marshall, A. (2017). What encourages people to carpool? An evaluation of factors with meta-analysis. *Transportation*, 44, 423-447. <https://doi.org/10.1007/s11116-015-9661-7>
- Pigalle, E., & Aguilera, A. (2023). Ridesharing in all its forms—Comparing the characteristics of three ridesharing practices in France. *Journal of Urban Mobility*, 3, 1-12, 100045.
- Ray, J. B., & Khedira, H. (2023). Results from a resilient citizen-based instant carpooling public service. *Transportation Research Procedia*, 72, 2800-2807. <https://doi.org/10.1016/j.trpro.2023.11.823>
- Rey-Merchán, M. D. C., López-Arquillos, A., & Pires Rosa, M. (2022). Carpooling systems for commuting among teachers: An expert panel analysis of their barriers and incentives. *International Journal of Environmental Research and Public Health*, 19(14), 1-12, 8533.
- Rijavec, R., Dadashzadeh, N., Žura, M., & Marsetič, R. (2020). Park and pool lots' impact on promoting shared mobility and carpooling on highways: The case of Slovenia. *Sustainability*, 12(8), 1-19, 3188.
- Shaheen, S., Cohen, A., & Bayen, A. (2018). The benefits of carpooling. *The Environmental and Economic Value of Sharing a Ride*, California Digital Library, University of California, 1-32, 10.7922/G2DZ06GF.
- Si, H., Shi, J., Hua, W., Cheng, L., De Vos, J., & Li, W. (2023). What influences people to choose ridesharing? An overview of the literature. *Transport reviews*, 43(6), 1211-1236. <https://doi.org/10.1080/01441647.2023.2208290>
- Si, H., Su, Y., Wu, G., Li, W., & Cheng, L. (2022). Can government regulation, carbon-emission reduction certification and information publicity promote carpooling behavior?. *Transportation Research Part D: Transport and Environment*, 109, 1-18, 103384.
- Simancas, W., Vinasco, C., Rosas-Satizábal, D., Ortiz-Ramirez, H. A., & Rodríguez-Valencia, A. (2024). Decision-making in open carpooling programs: Perspectives of drivers versus passengers. *Travel Behaviour and Society*, 36, 1-12, 100759.
- Spano, D., Mereu, V., Bacciu, V., Marras, S., Trabucco, A., Adinolfi, M., Barbato, G., Bosello, F., Breil, M., Chiriaco, M. V., Coppini, G., Essensfelder, A., Galluccio, G., Lovato, T., Marzi, S., Masina, S., Mercogliano, P., Mysiak, J., Noce, S., Pal, J., Reder, A., Rianna,

- G., Rizzo, A., Santini, M., Sini, E., Staccione, A., Villani, V., Zavatarelli, M. (2020). *Analisi del rischio. I cambiamenti climatici in Italia*. Fondazione CMCC - Centro Euro-Mediterraneo sui Cambiamenti Climatici.
- Tomás, R., Fernandes, P., Macedo, J., & Coelho, M. C. (2021). Carpooling as an immediate strategy to post-lockdown mobility: A case study in University Campuses. *Sustainability*, 13(10), 1-22, 5512.
- Tsai, Y. T., Yu, C. H., & Boonprakob, R. (2021). Assessing carpooling drivers and barriers: Evidence from Bangkok, Thailand. *Transportation research part F: traffic psychology and behaviour*, 82, 84-95. <https://doi.org/10.1016/j.trf.2021.07.017>
- Wang, Y., & Monchambert, G. (2024). Does subsidy increase carpooling usage? The case of short-distance carpooling in France. *LAET Working Paper 2024/03*, <https://shs.hal.science/halshs-04540642/document>
- Xiao, L., Wu, J., Sun, J., & Tian, Y. (2024). Money is power: Carpooling stimulus with evidence from an interactive long-term laboratory experiment. *Transport policy*, 152, 55-70. <https://doi.org/10.1016/j.tranpol.2024.04.013>
- Xu, D., & Zhang, Y. (2022). Immigrants' language skills and carpooling as need-based social networking: Evidence from large-scale national survey data. *Travel Behaviour and Society*, 29, 236-245. <https://doi.org/10.1016/j.tbs.2022.06.012>
- Yi, X., Lian, F., & Yang, Z. (2022). Research on commuters' carpooling behavior in the mobile internet context. *Transport Policy*, 126, 14-25. <https://doi.org/10.1016/j.tranpol.2022.06.016>
- Yin, B., Liu, L., Coulombel, N., & Vigié, V. (2018). Appraising the environmental benefits of ride-sharing: The Paris region case study. *Journal of cleaner production*, 177, 888-898. <https://doi.org/10.1016/j.jclepro.2017.12.186>