Low-Cost Shared Mobility Alternatives in Rural Areas: a Case Study of Ride-Sharing Benches in the German-speaking Community of Belgium

Negarsadat Madani[a], Lieve Creemers[b], Mehdi Moeinaddini[c,d*], Ismaïl Saadi[e,f,a], Mario Cools[g,h,a]

[a] Local Environment & Management Analysis (LEMA), Urban and Environmental Engineering (UEE), University of Liège, Belgium
[b] Transportation Research Institute (IMOB), Hasselt University, Belgium
[c] Queen's University Belfast, Centre for Public Health, UK
[d] Institute of Computer Science, University of Tartu, Tartu, Estonia
[e] Univ. Gustave Eiffel, IFSTTAR, COSYS-GRETTIA, France
[f] National Fund for Scientific Research (F.R.S.-FNRS), Belgium
[g] Faculty of Business Economics, Hasselt University, Belgium
[h] Department of Informatics, Simulation, and Modeling, KULeuven Campus Brussels, Belgium

Emails: n.madani@uliege.be, lieve.creemers@uhasselt.be, mehdi.moeinaddini@ut.ee, ismail.saadi@univ-eiffel.fr, mario.cools@uliege.be

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*Corresponding author

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This paper focuses on a low-cost shared mobility solution in the German-speaking Community of Belgium (Ostbelgien). Like many other rural areas, Ostbelgien is car-oriented and has low public transport coverage. The main objective of this paper is to introduce the concept of ride-sharing benches in Ostbelgien. In addition, an online survey was conducted to assess the knowledge of the concept and its potential use according to socio-economic, socio-cognitive, and geographic characteristics. The survey demonstrated that there is a high potential for using it in the future. Socio-economic and socio-cognitive factors determine the potential use of ride-sharing benches, whereas geographical factors predominantly influence knowledge of the concept. The users consider using the benches in combination with the scheduled bus service. This service can be a low-cost and practical shared mobility solution, especially for rural areas with low public transportation coverage. The locations of the benches can be integrated into an application to stimulate the use of the ride-sharing benches.

Keywords: ride-sharing; travel choices; ride-sharing benches; rural areas

1. INTRODUCTION

Due to the increase in cars and emissions globally, transportation planners and operators should stimulate the shift towards environment-friendly transport modes like public transport and shared travel options. However, a low frequency of public transport services affects users' satisfaction, particularly in rural areas, where there is often a lack of shared mobility options and public transportation coverage is not sufficient for the travel requirements of inhabitants (Ji & Gao, 2010). Furthermore, due to the geographical dispersion of activity locations, inhabitants of rural areas are often car-dependent. Therefore, not having a car or driving licence (which is common for older people or (temporarily) impaired persons) in these regions can even lead to social exclusion, lack of prospects, and isolation (European Network Rural Development, 2018; Osti, 2010).

Alternative mobility options, like ride-sharing, vanpooling, and demand-responsive transport systems (DRTS), are mobility solutions that may create the required connection with other regions and villages (Chan & Shaheen, 2012; Contreras & Paz, 2018; Osti, 2010). Moreover, travel options exist, such as hitchhiking, which involves accompanying others during the trip with simple facilities (Zhou, 2020). Hitchhikers count on others' help for their trips (Laviolette, 2016). However, travelling with such shared modes imposes privacy and safety concerns on drivers and passengers. The symbolic value that car drivers attribute to their cars makes them less like to share them with strangers (Chesters & Smith, 2001). Furthermore, passengers are concerned for personal safety and crimes such as robbery and violence. The risk of robbery and violence is usually higher for women and those who travel alone (Zhou, 2020).

In terms of mobility habits, there are some differences between rural and urban areas. For instance, in a study by Winslott Hiselius and Svensson, it was observed that more trips are made by car in rural areas due to the higher number of older people (Winslott Hiselius & Svensson, 2017). People in cities are more interested in short-distance trips by bike or public

transport, whereas rural habitants travel longer distances by car. Despite the high car dependency, few papers have worked on mobility in rural areas (European Network Rural Development, 2018). A study from Osti is one of the few studies on mobility in rural areas (Osti, 2010). The study indicates that people in rural areas travel less than others but have a higher travel distance. Therefore, shared mobility options covering long-distance trips can reduce car ownership in rural areas.

A study by Hine, Kamruzzaman and Blair (2012) in Northern Ireland revealed that women living in rural areas are less motivated to make long-distance trips and travel in the evenings because of safety concerns and difficulties associated with organising out-of-home and in-home activities together. Also, according to Hine et al. (2012), people who do not own a car make more trips by bus or foot. Connecting shared mobility options with buses and public transport in rural areas can be a solution that can enhance mobility for women, the elderly, and people who do not have a car. In addition, it is mentioned in Bauchinger et al. that flexible transport services can be set up to develop rural-urban connections in the network (Bauchinger et al., 2021). Small-scale transport services should be integrated within a broader transport system to cover a larger group of users. In this regard, multimodal hubs can make public transportation more attractive and present other services such as ride-sharing, enhancing flexibility in trip-making, and decreasing car dependency (Wang & Ross, 2019).

This paper focuses on a low-cost shared mobility solution in the German-speaking Community of Belgium (Ostbelgien). The community has 78,144 inhabitants and an area of 846 km², of which 751 km² are undeveloped. With an average population density of 91 inhabitants/km², the area is considered the most rural area in Belgium (Ostbelgien, 2021; Statbel, 2021). Ostbelgien comprises nine municipalities, with about a hundred residential areas, in the far east of Belgium. As shown in Figure 1, Ostbelgien is located close to the

German, Dutch, and Luxemburgian borders. The southern part of Ostbelgien is called 'Belgian Eifel', the northern part is called 'Land of Eupen'.

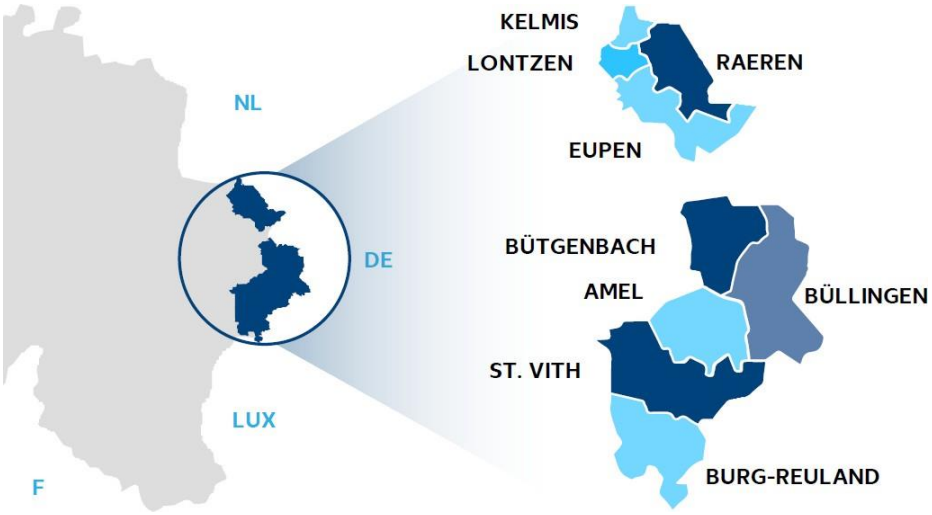


FIGURE 1. The 9 German-speaking Municipalities

Like many other rural areas, Ostbelgien is car-oriented. In 2021, car ownership equalled 537 passenger cars per 1000 inhabitants. Due to the region's vastness and hilly topography, there is a relatively low share of cycling compared to the rest of Belgium. If cycling infrastructure is present, it is primarily oriented toward recreational purposes. Public transport supply is rather limited, directly resulting from the region's rural nature, where public transport is often not cost-effective. Ostbelgien has two train stations, but there is no direct connection to neighbouring Germany. In terms of bus services, there are 33 bus routes. However, these operate at a very low frequency (the time between consecutive buses is considerable, increasing the waiting time significantly), and the schedules are primarily defined to serve school traffic. Cross-border travel also comes with an additional cost, often an additional barrier to using public transport in Ostbelgien (Ostbelgien, 2021).

Car dependency will always be present to some extent in rural areas. Notwithstanding, transport policies and operators should try to reduce this dependency. Therefore, in 2018, the

local mobility centre of Ostbelgien (Fahr mit) started the quick-built project of ride-sharing benches (Fahr Mit, 2021). The concept is straightforward. Citizens can take a seat on one of the distinctive blue-coloured benches to signal that they need a ride. The benches are situated on the main access roads of the municipalities, so drivers who travel in the same direction can stop their car and offer a ride if available seats are available. Participation is voluntary, and there are no financial compensations. So, this is a cheap solution that needs no technical knowledge. Since the system's launch, 29 benches have been accomplished, primarily in the Land of Eupen (the roll-out of the ride-sharing benches system is currently limited to the Land of Eupen). However, network expansions are also planned in the Belgian Eifel (Fahr Mit, 2021). The following sections introduce this concept in detail and evaluate whether the knowledge of the concept of ride-sharing benches and the potential use of the ride-sharing depend on the socio-economic, socio-cognitive, and geographic characteristics.

2. Concept of ride-sharing benches

From a technical point of view, Furuhata et al. (Furuhata et al., 2013) defined four patterns of ride-sharing: (*i*) driver and passenger have similar origins and destinations, (*ii*) both origin and destination of the passenger are on the way of the driver's route, (*iii*) both locations to pick-up and drop-off the passenger are on the path of the driver, but they are not precisely the origin and destination of the passenger (ride-sharing is a part of the passenger's trip), and (iv) the passenger's pick-up or drop-off point or both are not on the route of the driver, so the driver should somehow reach the points to meet the passenger and drop him off. Possible ride-sharing ideas are usually in one of these categories. For example, the ride-sharing benches in Ostbelgien can be categorised in the third category since the benches are located along the driver's route, but this isn't the passenger's origin or destination. Figure 2 shows a ride-sharing bench in Lontzen (Belgium).

FIGURE 2. Ride-sharing bench in Lontzen (Belgium)

Recent studies tried to introduce some factors that might affect the users' decisions to ride-share. First, some factors, such as demographic and personal characteristics, arise at the individual level. For instance, it is observed that the tendency to ride-share depends on age: older people are less likely to ride-share than young people (Delhomme & Gheorghiu, 2016; Gärling et al., 2000; Neoh et al., 2017). Besides, Tirachini and del Río (2019) showed that car ownership reduces the ride-sharing frequency in neighbourhoods with a low population. Moreover, Neoh et al. (2017) and Delhomme and Gheorghiu (2016) indicated that young people are usually more eager to adopt ride-sharing. They also found a significant effect of gender: women are almost three times more likely to ride-share than men. The effect of gender is also confirmed by DeLoach and Tiemann (DeLoach & Tiemann, 2012). In addition, the meta-analysis of Neoh et al. (Neoh et al., 2017) shows that people with higher incomes and a higher level of education are more likely to ride-share. Providing facilities such as HOV lanes, dedicated ride-sharing parking lots, and a ticketing system like the CARLOS project can

motivate travellers to carpool (Beutler n.d.; Handke, V & Jonuschat, 2012). As a quick build solution, there are no demographic and personal characteristics relevant studies for the ride-sharing benches in Ostbelgien. Since the benches have been used for a while, and people are familiar with this concept, it is an excellent time to consider the effects of individual-level factors. Information on the impact of these individual-level factors is helpful for decision-makers to make informed decisions regarding whether or not to make this quick-build solution as a permanent option. Therefore, the next section of this paper is dedicated to assessing the dependency of the potential use of the ride-sharing benches on socio-economic, socio-cognitive, and geographic characteristics.

Second, trip-related factors may also affect the probability of ride-sharing. Van Der Waerden, Lem, and Schaefer (2015) observed that attributes related to time and cost, such as waiting time at the start point, travel time, and trip expenses, highly influence people's tendency to ride-share. However, the number of individuals in the ride-sharing vehicle does not seem to play a key role. A considerable reduction in travel time is necessary to attract people to ride-share (Giuliano, 1990). Rietveld et al. (Rietveld et al. 1999) observed that travel time increased by 17% for ride-sharers, which might make them unsatisfied. It is also found by Neoh et al. (Neoh et al., 2017) that the discomfort of waiting for others to join the carpool can reduce its attractiveness. The ride-sharing benches in Ostbelgien can reduce this waiting time by making the ride requests visible for the drivers who can share their trips.

Some psychological factors can also affect the decision to ride-share. Neoh et al. (2017) showed that people are more likely to adopt ride-sharing if they realise it is comfortable. People might avoid ride-sharing because of their comfort and privacy. Safety is also an important factor that should be considered by the service operators (Gupta et al., 2019). Safety issues sometimes exist for drivers as well because they feel responsible for the passengers. Social and cultural characteristics can also affect the decision to ride-share: people who feel responsible about the

environment seem more eager to ride-share (Delhomme and Gheorghiu, 2016; Neoh et al., 2017). Using the ride-sharing benches in Ostbelgien makes it possible to meet the ride requesters and drivers before accepting or refusing the trip request. This fact can help reduce the adverse psychological effects.

Marketing can also have a significant role in the tendency of travellers to ride-share. Neoh et al. (Neoh et al., 2017) showed that financial advantages could motivate people more than other benefits such as parking discounts. Parking incentives are more attractive when finding parking is difficult. Although financial advantages can motivate travellers, their impact might be limited and should be combined with other influential factors. An online platform that facilitates finding ride-sharers in the network can also be an important stimulus. This could be in the form of a smartphone application (Neoh et al., 2017), which, in turn, can be integrated into a Mobility-as-a-Service (MaaS) platform. Combining modes can also encourage users to have more flexibility in planning their trips and thus motivate them to use more sustainable modes (Bauchinger et al., 2021; Christiaanse, 2019; Lygnerud & Nilsson, 2020; Matyas & Kamargianni, 2019; Thao et al., 2021; Utriainen & Pöllänen, 2018). Although applying technology can be helpful, considering the low level of being comfortable with technology in some rural areas, the ride-sharing benches concept that does not require technology can attract more users. However, some optional technological enhancements can be useful. For example, to stimulate the use of the ride-sharing benches, the locations of the benches can be integrated into an application.

3. Potential users

To evaluate the concept of ride-sharing benches in Ostbelgien, an online survey was conducted and distributed among the region's inhabitants. The data was collected on a person-based level from the beginning of April 2021 to late May 2021. The respondents were asked to reply to the questions considering the pre-COVID situation to avoid potential COVID-19 effects. The target population was the German-speaking community's residents aged 17 years or older (population size: 63 901 persons). Several channels were used for the distribution process, including the websites of Ostbelgien, Fahr mit, the different municipalities, and a Facebook campaign to increase the response rate further. All these efforts lead to a representative sample for the study. In total, information from 372 respondents was collected. After a data cleaning process, the information of 360 respondents (sample rate of 56.34%) was retained. Respondents who were not residents of Ostbelgien or respondents who indicated that they did not agree with the privacy terms of the survey were removed from the dataset.

3.1 Data

The survey consisted of three main parts. The first part focused on collecting socio-demographic and socio-cognitive variables. The second part concentrated on the current travel behaviour of the respondents, and the last part of the survey collected information on the ride-sharing benches. More detailed data was obtained on the potential users of the ride-sharing benches. An optimal correspondence between the sample composition and the Ostbelgien population (of which perfect knowledge was available) was achieved by weighing the sample using the true population-based conditional distribution for age and gender (Statbel 2021).

Table 1 provides a basic description of the key variables and the different factors that might account for these variables. The results show that most respondents (76.4%) are familiar

with the concept of ride-sharing benches. The actual users and the potential users of the ride-sharing benches is considerably significant (about 40% of respondents indicated they use or would consider using the ride-sharing benches).

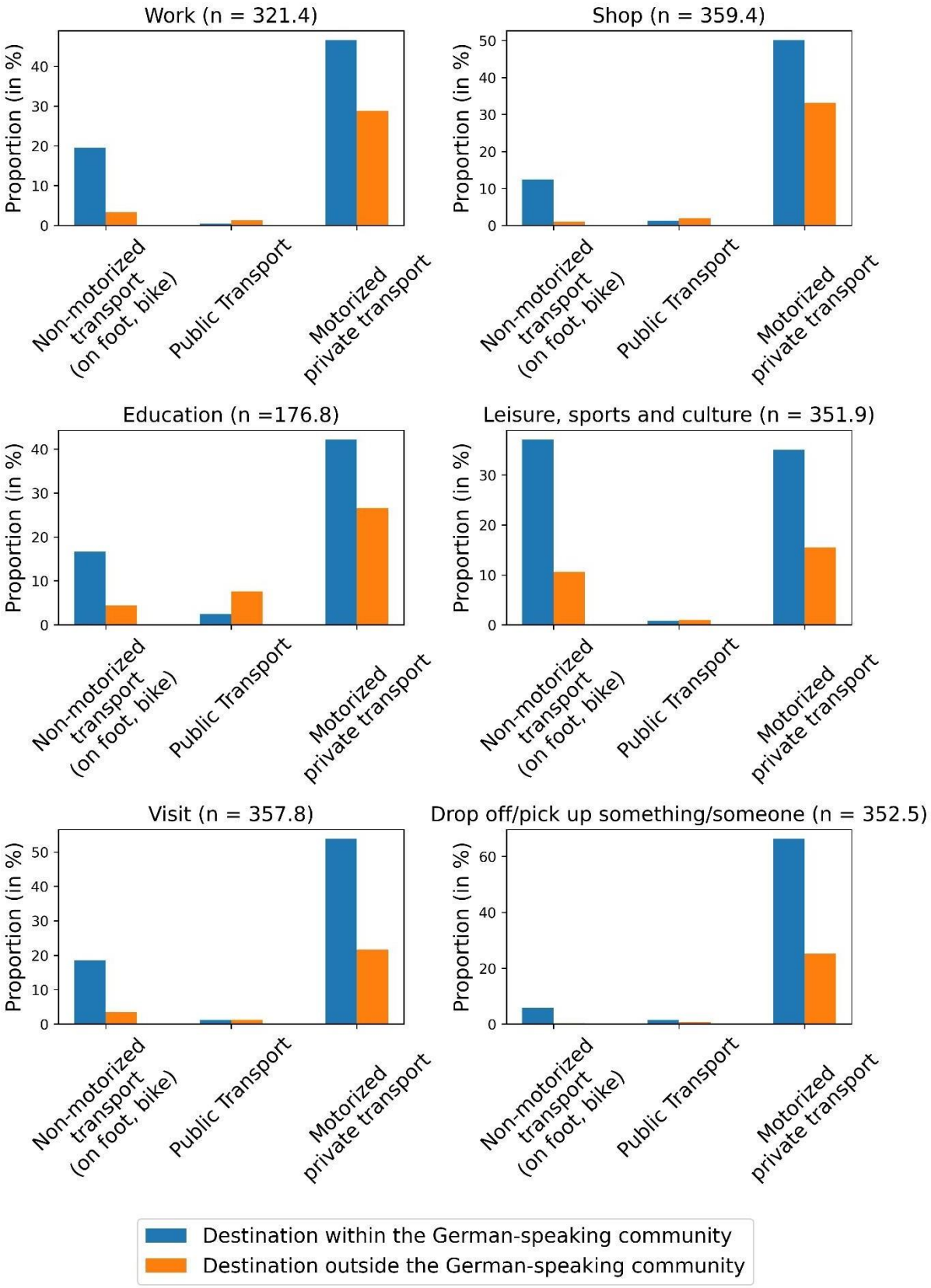
TABLE 1. Description of Variables of Interest and Potential Influencing Factors (n = 359.4)

Label	Description	Descriptive statistics
Dependent variables		
Knowledge	Respondent is familiar with the concept of ride-sharing benches	Knowledge (76.4%) No Knowledge (23.6%)
User Type	Potential users	40.4%
Socio-economic characteristics		
Age	Years passed since birth	17-34 years (25.2%) 35-64 years (66.2%) +65 years (8.6%)
Sex	Gender	Female (50.8%) Male (49.2%)
Car_av	Car availability	Yes, most of the time (87.6%) Yes, sporadically (6.6%), No (5.8%)
Socio-cognitive characteristics		
Imp_fast	How important is a fast trip?	Not important (13.0%) Neutral (16.8%) Important (70.2%)
Imp_comfort	How important is a comfortable trip?	Not important (11.4%) Neutral (24.7%) Important (63.9%)
Imp_inexp	How important is an inexpensive trip?	Not important (27.5%) Neutral (35.9%) Important (36.6%)
Imp_eco	How important is an ecologically sound trip?	Not important (28.3%) Neutral (41.7%) Important (30.0%)
Geographical characteristics		
Surf_res	Residential area (in km²) of the municipality where the respondent lives	Mean: 3.8 Standard Deviation: 2.3 < 2.5 km² (33.9%) > 2.5 km² (66.1%)
Inc	Average income (€ / inhabitant) of the municipality where the respondent lives	Mean: 18243.1 Standard Deviation: 1052.3 <18 000 €/inh. (35.3%) > 18 000 €/inh. (64.7%)
Pop_dens	Population density (inhabitants/km²) of the municipality where the respondent lives	Mean: 173.9 Standard Deviation: 156.1 < 100 inh/km² (36.9%) > 100 inh/km² (63.1%)
Region	The region within the German-speaking community where the respondent lives	Land of Eupen (63.1%) Belgian Eifel (36.9%)

Regarding the potential influencing factors, in terms of socio-economic characteristics, the high car ownership draws attention: almost 9 out of 10 respondents have a car available most of the time. This confirms that Ostbelgien is strongly car-oriented. Concerning the socio-cognitive characteristics, it can be depicted that inhabitants attach great importance to a fast and comfortable trip. With respect to the geographical characteristics, one should note that these

characteristics were defined at the municipality level. The descriptive statistics clearly confirm the rural nature of the study area.

Figure 3 provides insight into the current travel behaviour of Ostbelgien residents. In accordance with Table 1, the strong car dependency can be depicted. The share of motorised private transport is high for all activities, but especially for pick up/drop off trips: more than 9 out of 10 respondents (66.3% + 25.2%) use their car for this type of trip. Also, for commuting trips (75.2%), shopping trips (83.2%), and visit trips (75.4%), the share of car use is very high. The strength of car dependency becomes more apparent when these numbers are compared with the most recent Belgian national household travel survey (Monitor, 2018). In the latter survey, the share of car use equals respectively 58% and 65% for commuting and shopping trips. Despite the large share of car trips, their majority is realised within Ostbelgien to be more than 60%, and this is true for all trip motives.



220220
221221 FIGURE 3. Main Transport Mode Choice, Categorised by Trip Motive and Trip Destination

3.2 Results

To assess whether the knowledge of the concept of ride-sharing benches and the potential use of the ride-sharing depend on the socio-economic, socio-cognitive, and geographic characteristics, different independence tests (Pearson chi²-tests) were tabulated. In addition, Cramer's V was tabulated for each of the relations. Cramer's V is a measure of association based on the Chi²-statistic, varying from 0 (no association between the variables) to 1 (complete association). This association test can be helpful to have some ideas about the strength of potential associations between bench usage and socio-economic, socio-cognitive, and geographic characteristics. For example, the strongest association with bench usage based on the Cramer's V test (cf. Table 2) is related to the population density and region, while the weakest one is related to gender. Table 2 provides the results of the Chi²-independence tests and the corresponding frequency tables on which these tests were based.

Concerning the (potential) use of the ride-sharing benches, one could depict a significant dependence of the potential use on car availability and gender. The association of car availability with potential use is larger than the one of gender. The frequency tables show that the willingness to use the ride-sharing benches is the largest amongst the respondents who only have a car available sporadically. Regarding gender, males (54%) appear to be less enticed to use the ride-sharing benches than females (65%).

Regarding the socio-cognitive factors, the importance of travel costs (inexpensive travelling) and the importance of environmental friendliness (ecological soundness) significantly influence the potential use of ride-sharing benches. Respondents that attribute high importance to environmental friendliness or low travel costs are more likely to use the ride-sharing benches. Surprisingly, none of the considered geographical factors impacted the potential use of the ride-sharing benches.

With respect to the knowledge of the ride-sharing benches, contrary to the findings of the potential use, especially geographical characteristics have a significant effect. In contrast, so-cognitive factors do not play any role. The knowledge depends on the average income in the municipality, the region, and the mean population density. Respondents living in municipalities with a higher average income, a higher population density, and situated in the Land of Eupen have the most knowledge about the concept. Besides, also car availability impacts the knowledge of the ride-sharing benches: respondents that do not have access to a car have the least knowledge of the concept.

TABLE 2. Dependency of Various Characteristics on Knowledge and Potential use of the Ride-sharing Benches and their Frequencies (n =359.4)

(Potential) use of the ride-sharing benches					
Socio-economic characteristics					
		Yes	No	**χ^2 Signif.**	**Cramer's V**
Car_av	Yes, most of the times	46.3%	53.7%	**	0.1760
	Yes, sporadically	72.1%	27.9%		
	No	37.7%	62.3%		
Sex	Female	45.6%	54.4%	*	0.1070
	Male	35.1%	64.9%		
Age	17-34 years	40.4%	59.6%	NS	0.0015
	35-64 years	40.5%	59.5%		
	+65 years	40.2%	59.8%		
Socio-cognitive characteristics					
		Yes	No	**χ^2 Signif.**	**Cramer's V**
Imp_inexp	Not important	38.3%	61.2%	*	0.1494
	Neutral	32.8%	67.3%		
	Important	49.7%	50.3%		
Imp_eco	Not important	34.5%	65.5%	**	0.1936
	Neutral	34.1%	65.9%		
	Important	55.0%	45%		
Imp_comfort	Not important	55.3%	44.7%	NS	0.1093
	Neutral	39.7%	60.3%		
	Important	38.1%	61.9%		
Imp_fast	Not important	51.6%	48.4%	NS	0.0897
	Neutral	36.7%	63.3%		
	Important	39.3%	60.7%		
Geographical characteristics					
		Yes	No	**χ^2 Signif.**	**Cramer's V**
Inc	< 18000 €/inh	41.2%	58.8%	NS	0.0110
	> 18000 €/inh	40.1%	59.9%		

Region	Land of Eupen	41.1%	58.9%	NS	0.0173
	Belgian Eifel	39.3%	60.7%		
Surf_res	<2.5 km²	39.9%	60.1%	NS	0.0084
	>2.5 km²	40.8%	59.2%		
Pop_dens	< 100 inh/km²	39.3%	60.7%	NS	0.0173
	> 100 inh/km²	41.1%	58.9%		
Knowledge of the concept of ride-sharing bench					
Socio-economic characteristics					
		Yes	No	**χ² Signif.**	**Cramer's V**
Car_av	Yes, most of the times	77.7%	22.3%	*	0.1595
	Yes, sporadically	81.9%	18.1%		
	No	49.4%	50.6%		
Sex	Female	77.4%	22.6%	NS	0.0249
	Male	75.3%	24.7%		
Age	17-34 years	74.8%	25.2%	NS	0.0221
	35-64 years	76.9%	23.1%		
	+65 years	76.9%	23.1%		
Socio-cognitive characteristics					
		Yes	No	**χ² Signif.**	**Cramer's V**
Imp_inexp	Not important	78.9%	21.1%	NS	0.0366
	Neutral	75.5%	24.5%		
	Important	75.4%	24.6%		
Imp_eco	Not important	69.6%	30.4%	NS	0.1009
	Neutral	79.4%	20.6%		
	Important	78.6%	21.4%		
Imp_comfort	Not important	77.2%	22.8%	NS	0.0271
	Neutral	74.4%	25.6%		
	Important	77.0%	23.0%		
Imp_fast	Not important	64.0%	36.0%	NS	0.1124
	Neutral	77.6%	22.4%		
	Important	78.4%	21.6%		
Geographical characteristics					
		Yes	No	**χ² Signif.**	**Cramer's V**
Inc	< 18000 €/inh	67.0%	33.0%	**	0.1624
	> 18000 €/inh	81.5%	18.5%		
Region	Land of Eupen	90.1%	9.9%	***	0.4233
	Belgian Eifel	52.9%	47.2%		
Surf_res	<2.5 km²	72.8%	27.2%	NS	0.0606
	>2.5 km²	78.2%	21.8%		
Pop_dens	< 100 inh/km²	52.9%	47.1%	***	0.4233
	> 100 inh/km²	90.1%	9.9%		

256 *p-value < .05, **p-value < .01, ***p-value < .001, NS = not significant.
257 Cf. Table 1 for the variable definitions.
258258

259 Table 3 gives an overview of the personal motives for using the ride-sharing benches
260 and for which types of trips. Among the reasons, sustainability motives play the most important
261 role in using the ride-sharing benches for users. Besides, social reasons (e.g., helping a waiting

passenger), and the fact that it is for free, are important motivators. In contrast, not being able to drive a car (no car possession and lack of holdership of a driving licence) or travel speed was not frequently cited as a motivation to use the ride-sharing benches. Regarding the trip motive, users mainly want to use the ride-sharing benches for commuting trips followed by visiting friends/family. Shopping is also an important trip motive, whereas, for school trips, the interest in using the ride-sharing benches is low. A possible explanation for the latter is the better offer of public transport in line with school schedules.

TABLE 3. Motive for the Use of Ride-sharing Benches (n = 145.4)

Motive for the use of ride-sharing benches (multiple answers possible)	
Do not have/do not own a car	6.4%
Do not own a driving licence	2.1%
Free trip	26.0%
No/insufficient public transportation in municipality	15.2%
Sustainable transportation mode	65.9%
Faster trip	5.6%
Social reasons	31.0%
Trip motive for the use of ride-sharing benches (multiple answers possible)	
Commuting trips	37.4%
Shopping trips	25.9%
School trips	4.5%
To family/friends	33.3%

Figure 4 shows the variables which determine the success of the ride-sharing benches. The share of users that consider the use of the ride-sharing benches in combination with another mode of transport is considerable (66.5%). About half of the users prefer the combination of the benches with the bus. With regard to the dominant factors in determining the location of the ride-sharing benches, most respondents indicated that the ride-sharing benches must be located on a road with a lot of traffic or on a connecting road to a nearby village. Besides, the location must provide shelter against adverse weather conditions, as snow and hail are frequent in Ostbelgien.

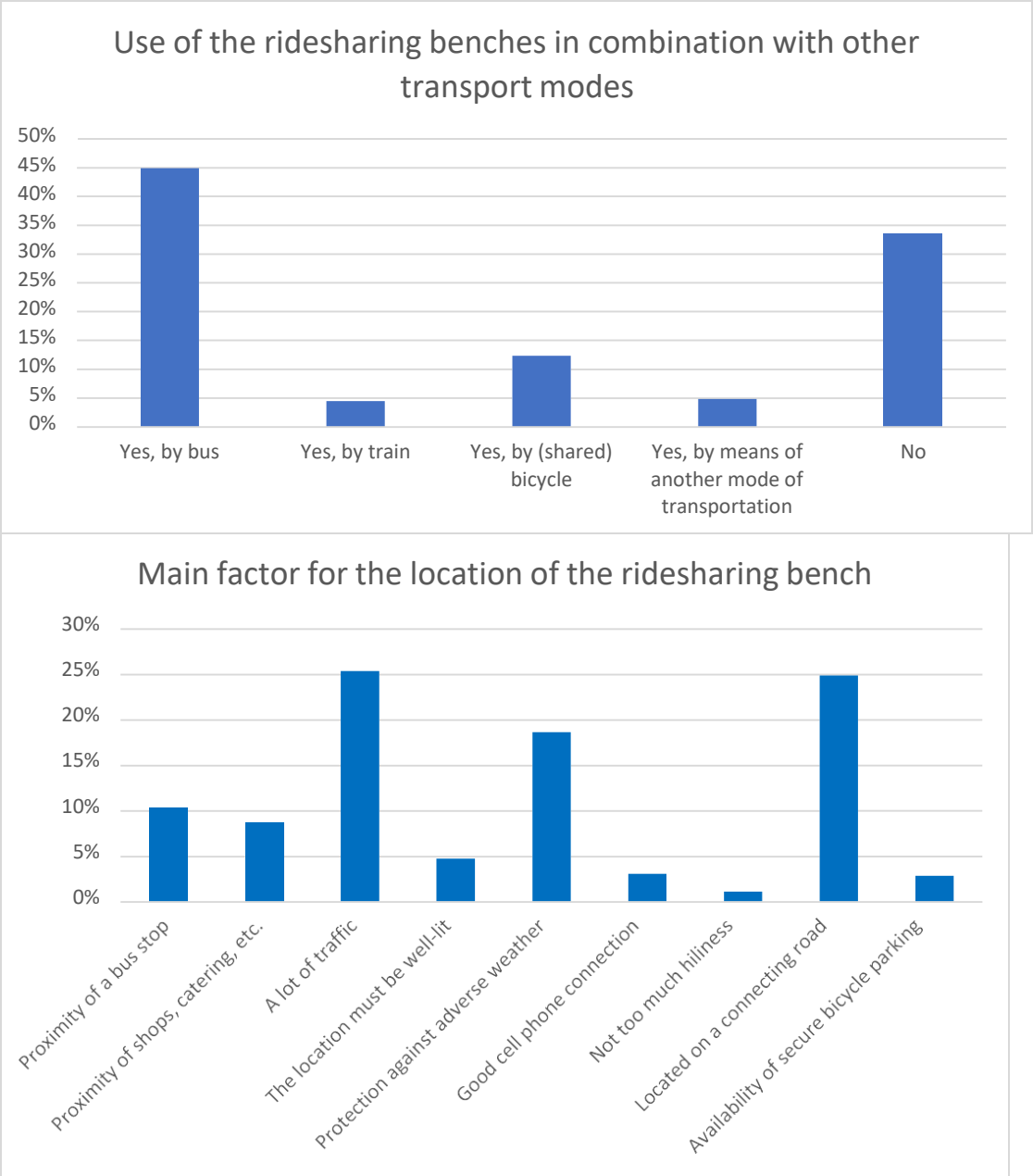


FIGURE 4. Factors that Help Determine the Success of the Ride-sharing Benches

Several reasons are considered to investigate why people are not willing to use ride-sharing benches. The reasons indicate that some people do not use the ride-sharing benches because they own a car (39.1%) and do not need this service (18.0%). Some other respondents prefer to travel alone (5.4%), and they feel unsafe trusting another person (16.6%). This service

289 is not desirable for some as there is no guarantee of a return journey (17.4%), the journey takes
290 longer (5.4%), and they are cautious about the Covid-19 health measures (2.1%).

The utility of the ride-sharing benches appears to be too limited for those that have a car at their disposal. The lack of trust in another person (unsafety) is the other frequently mentioned barrier.

4. DISCUSSION AND CONCLUSION

This paper introduces the concept of the ride-sharing benches in Ostbelgien and investigates the users of the benches. The results of the descriptive statistics and the chi²-tests pinpointed that socio-economic and socio-cognitive factors determine the use of the benches. In contrast, geographical factors predominantly influence knowledge of the concept. Most inhabitants (65%) of Ostbelgian make their trips within the region which underlines the potential of the ride-sharing benches. As most trips are short and medium-distance, further development of the network of benches on main access roads of villages in Ostbelgian can enhance the system's success. Despite the system's potential, potential users need to be convinced actually to use the ride-sharing benches. Literature (e.g., (Neoh et al., 2017)) shows the important role that marketing can play in this regard.

Analysis of the socio-economic variables showed the dependency of the potential use of the ride-sharing benches on car availability and gender. Also, the literature showed the role these socio-economic variables could play, albeit age did not play a role in our study. In line with the literature (Tirachini & del Río, 2019), car ownership reduces the probability of ride-sharing. Regarding gender, the results showed that males are less likely to use the system in comparison to females. Although some studies, as discussed in the introduction, seem to contradict this, in other studies, it is indicated that women prefer ride-sharing more than men (see, e.g., Delhomme & Gheorghiu (2016) and Neoh et al. (2017)). Further exploration of the gender differences in the data reveals that women cite sustainability more often as a motivation to use the ride-sharing benches (77.9% vs 61.1% for males), as well as the lack of sufficient

316 public transport alternatives (15.8% vs 9.4% for males). In contrast, differences in car
317 availability are negligible and therefore do not explain the higher tendency to use the ride-
318 sharing benches by females in our study (88.3% of the female respondents have most of the
319 time a car available versus 86.8% of the male respondents).

320 In terms of socio-cognitive factors, this is observed that respondents that attribute large
321 importance to ecological and inexpensive travelling are more likely to use the ride-sharing
322 benches as a cheap service that does not require special infrastructures and uses the cars that
323 are on the way anyway. The literature review also acknowledged the importance of socio-
324 cognitive factors. A pro-environmental orientation appears to increase the likelihood of ride-
325 sharing, which is confirmed by our findings. Given that ecology and inexpensive travelling are
326 important motives for users, marketing actions with respect to the ride-sharing benches should
327 be tailored to these motives. So, there is a high potential for the usage of the benches as a cheap
328 and practical solution, especially in the rural areas with low coverage of public transport
329 services.

330 Regarding the knowledge of the system of ride-sharing benches, especially geographical
331 aspects were predominant. Municipalities of the Land of Eupen and the ones with a higher
332 average income and population density were more likely to be aware of the concept. This
333 geographical dependency can be easily explained. The roll-out of the ride-sharing benches
334 system is now limited to the Land of Eupen and has not yet been initiated in the Belgian Eifel.
335 Compared to high-tech services, which usually need prior technological knowledge, ride-
336 sharing benches are a quick-built project that is easy to introduce as they are very simple and
337 low-tech solutions that need no technical experience and are easy to use, especially for older
338 people.

339 According to the results, the service has the potential to attract more users in the future.
340 The outcome of users shows that the ride-sharing benches can be more common in the future,

especially with raising people's knowledge about the concept and in combination with other modes. Finding the most appropriate locations for the benches and giving more travel information to the passengers (e.g., waiting time on the bench) via an application can also be desirable for users.

Potential users are not convinced that the system results in a shorter travel time, mainly because of the uncertainty of the time they need to sit on the ride-sharing bench before someone takes them along. Further research is needed to objectively determine the average waiting time on the ride-sharing benches objectively and to calculate complete travel times to compare the system's performance. The feeling of safety was highlighted as an important barrier as well. This could be tackled by installing ANPR cameras near the ride-sharing benches, but this raises issues with respect to privacy. To what extent potential privacy concerns would be a new barrier? The safety aspect is also reported in the literature as a constraining factor (Gupta et al., 2019).

Most users of the ride-sharing benches consider using them in combination with another transport mode, especially in combination with the scheduled bus service. Besides, there is a certain interest in the combination of the use of the rides-sharing benches with (e-)bikes. To further stimulate the use of the ride-sharing benches, the locations of the benches should be integrated into an application, where the complementarity of the system with other transport modes becomes clearer. For example, an optional MaaS app could be an extra stimulus to use the ride-sharing benches (Bauchinger et al., 2021; Christiaanse, 2019; Lygnerud & Nilsson, 2020; Matyas & Kamargianni, 2019; Thao et al., 2021; Utriainen & Pöllänen, 2018).

The focus of this paper was laid on the evaluation of the potential of a low-cost shared mobility solution, i.e. a system of ride-sharing benches. Future research could focus on comparing the ride-sharing benches and other ride-sharing or hitchhiking-related studies, especially in rural areas. In-depth interviews with female users of the ride-sharing benches

366 could shed light on the intrinsic motivations and barriers to using the benches and sharing rides

367 in general.

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REFERENCES

Bauchinger, Lisa, Anna Reichenberger, Bryonny Goodwin-Hawkins, Jurij Kobal, Mojca Hrabar, and Theresia Oedl-Wieser. (2021) Developing Sustainable and Flexible Rural-Urban Connectivity through Complementary Mobility Services, *Sustainability (Switzerland)*, 13(3):1–23. doi: 10.3390/su13031280.

<Beutler, Martin. n.d., CARLOS GmbH>. Available at https://carlos.ch/index_en.html

Chan, Nelson D., and Susan A. Shaheen. (2012) Ride-sharing in North America: Past, Present, and Future, *Transport Reviews*, 32(1):93–112. doi: 10.1080/01441647.2011.621557.

Chesters, Graeme, and David Smith. (2001) The Neglected Art of Hitch- Hiking: Risk, Trust and Sustainability, *Sociological Research Online*, 6(3). doi: 10.5153/sro.605.

Christiaanse, Rob. (2019) Mobility as a Service, 83–92. doi: 10.1145/3308560.3317050.

Contreras, Seth D., and Alexander Paz. (2018) The Effects of Ride-Hailing Companies on the Taxicab Industry in Las Vegas, Nevada, *Transportation Research Part A: Policy and Practice*, 115(November 2017):63–70. doi: 10.1016/j.tra.2017.11.008.

Delhomme, Patricia, and Alexandra Gheorghiu. (2016) Comparing French Carpoolers and Non-Carpoolers: Which Factors Contribute the Most to Carpooling?, *Transportation Research Part D: Transport and Environment*, 42:1–15. doi: 10.1016/j.trd.2015.10.014.

DeLoach, Stephen B., and Thomas K. Tiemann. (2012) Not Driving Alone? American Commuting in the Twenty-First Century, *Transportation*, 39(3):521–37. doi: 10.1007/s11116-011-9374-5.

European Network Rural Development. (2018) Smart Villages and Rural Mobility, (1):1–8.

Furuhata, Masabumi, Maged Dessouky, Fernando Ordóñez, Marc Etienne Brunet, Xiaoqing Wang, and Sven Koenig. (2013) Ridesharing: The State-of-the-Art and Future Directions, *Transportation Research Part B: Methodological*, 57:28–46. doi: 10.1016/j.trb.2013.08.012.

Gärling, Tommy, Anita Gärling, and Anders Johansson. (2000) Household Choices of Car-Use Reduction Measures, *Transportation Research Part A: Policy and Practice*, 34(5):309–20. doi: 10.1016/S0965-8564(99)00039-7.

Giuliano, G. E. N. E. V. I. E. V. E. (1990) Impact of High Occupancy Vehicle Lanes on Carpooling Behavior.

Gupta, Sandeep, Attaullah Buriro, and Bruno Crispo. (2019) DriverAuth: Behavioral Biometric-Based Driver Authentication Mechanism for on-Demand Ride and Ridesharing Infrastructure, *ICT Express*, 5(1):16–20. doi: 10.1016/j.icte.2018.01.010.

Handke, V., & Jonuschat, H. (2012) Flexible Ridesharing: New Opportunities and Service Concepts for Sustainable Mobility, *Springer Science & Business Media.*

Ji, Jue, and Xiaolu Gao. (2010) Analysis of People's Satisfaction with Public Transportation in Beijing, *Habitat International*, 34(4):464–70. doi: 10.1016/j.habitatint.2009.12.003.

Laviolette, Patrick. (2016) Why Did the Anthropologist Cross the Road? Hitch-Hiking as a Stochastic Modality of Travel, *Ethnos*, 81(3):379–401. doi: 10.1080/00141844.2014.986149.

Lygnerud, Kristina, and Anna Nilsson. (2020) Business Model Components to Consider for Ridesharing Schemes in Rural Areas – Results from Four Swedish Pilot Projects, *Research*

in Transportation Business and Management, (xxxx):100553. doi: 10.1016/j.rtbm.2020.100553.

Matyas, Melinda, and Maria Kamargianni. (2019) *Survey Design for Exploring Demand for Mobility as a Service Plans*, Vol. 46. Springer US.

<Mit, Fahr>. Available at https://fahrmit.be

Monitor. (2018) Enquête Monitor Over De.

Neoh, Jun Guan, Maxwell Chipulu, and Alasdair Marshall. (2017) What Encourages People to Carpool? An Evaluation of Factors with Meta-Analysis, *Transportation*, 44(2):423–47. doi: 10.1007/s11116-015-9661-7.

<Ostbelgien>. Available at https://ostbelgienstatistik.be/themen

Osti, Giorgio. (2010) Mobility Demands and Participation in Remote Rural Areas, *Sociologia Ruralis*, 50(3):296–310. doi: 10.1111/j.1467-9523.2010.00517.x.

Rietveld, Piet, Bert Zwart, Bert Van Wee, and Toon Van Den Hoorn. (1999) On the Relationship between Travel Time and Travel Distance of Commuters Reported versus Network Travel Data in the Netherlands, 269–87.

<Statbel, Population by Place of Residence, Nationality, Marital Status, Age and Sex>. Available at https://statbel.fgov.be/nl/themas/bevolking/structuur-van-de-bevolking

Thao, Vu Thi, Sebastian Imhof, and Widar von Arx. (2021) Integration of Ridesharing with Public Transport in Rural Switzerland: Practice and Outcomes, *Transportation Research Interdisciplinary Perspectives*, 10(March):100340. doi: 10.1016/j.trip.2021.100340.

Tirachini, Alejandro, and Mariana del Río. (2019) Ride-Hailing in Santiago de Chile: Users' Characterisation and Effects on Travel Behaviour, *Transport Policy*, 82(November 2018):46–57. doi: 10.1016/j.tranpol.2019.07.008.

Utriainen, Roni, and Markus Pöllänen. (2018) Review on Mobility as a Service in Scientific Publications, *Research in Transportation Business and Management*, 27(October):15–23. doi: 10.1016/j.rtbm.2018.10.005.

Wang, Fangru, and Catherine L. Ross. (2019) New Potential for Multimodal Connection: Exploring the Relationship between Taxi and Transit in New York City (NYC), *Transportation*, 46(3):1051–72. doi: 10.1007/s11116-017-9787-x.

Winslott Hiselius, Lena, and Åse Svensson. (2017) E-Bike Use in Sweden – CO2 Effects Due to Modal Change and Municipal Promotion Strategies, *Journal of Cleaner Production*, 141:818–24. doi: 10.1016/j.jclepro.2016.09.141.

Zhou, Lingxu. (2020) Hitchhiking Tourism and Social Trust: Exploring Chinese Experiences through Travel Blogs, *Annals of Tourism Research*, 81(July 2018):102853. doi: 10.1016/j.annals.2019.102853.