

Next Generation Ridepooling

How to leverage the full
value of on-demand mobility



Key learnings

Cities and rural areas are facing very different mobility challenges in times of climate crisis, political targets for providing public services, and demands for participation. The idea is the five-minute city¹, i.e. a city in which everything that fulfills our daily needs is within a five-minute reach. This old approach is becoming a very strong vision again, and is currently driving more and more cities. But how do we reclaim the city for people without losing the comfort of private mobility? How do we empower suburban and rural areas to be attractive without personal cars?



We at door2door are sure:

On-demand ridepooling will unfold its huge potential as soon as we want and are willing to put the effort in it. The first steps have been successfully taken; the “tool” just needs to be used with courage on a large scale. And it will. Because legal regulations and the cities’ desire to be climate-friendly are currently changing public and shared mobility for the better.

With this white paper we - the leading German service and software provider for ridepooling projects - would like to outline a solution that closes a wide range of different mobility gaps. This solution can be implemented quickly and meets future requirements. On-demand ridepooling is data-driven and tailored to customer needs from the very start - the perfect solution between flexible but highly inefficient use of private cars and the traditional

public transport operator (PTO) business. This tool provides an ad-hoc solution that focuses on mobility needs that currently are not covered.

Mixed fleets, mixed use cases:
The real uncaptured value lies in increasing the vehicle uptime across all fleets. Stronger integration into the public transport network and easy-to-design, intelligent pricing together with holistic approaches to participation and inclusion result in mobility for all at a very profitable level. Ridepooling will individualize public transport and is the only option on the table for dramatically reducing traffic in cities.

On the following pages, we will elaborate and discuss how we identified these key challenges and how we can overcome them by leveraging several tools to foster the true benefits that ridepooling technology has to offer.

A shift in public transportation

Some of the most recent trends in public transportation have been characterized by a shift in the perspective of operators:

- Interacting with passengers as clients and a stronger focus on a service-oriented attitude
- Introducing new modes of transportation - especially serving the first and last mile
- Introducing widespread digitalization with more sophisticated MaaS apps and an ever-growing smart electric infrastructure
- Using the established brand of local PTOs as a point of trust compared to globally active, but anonymous corporates
- Partnering with local businesses such as taxi companies instead of buying huge fleets, followed

by an even better approach with autonomous vehicle fleets

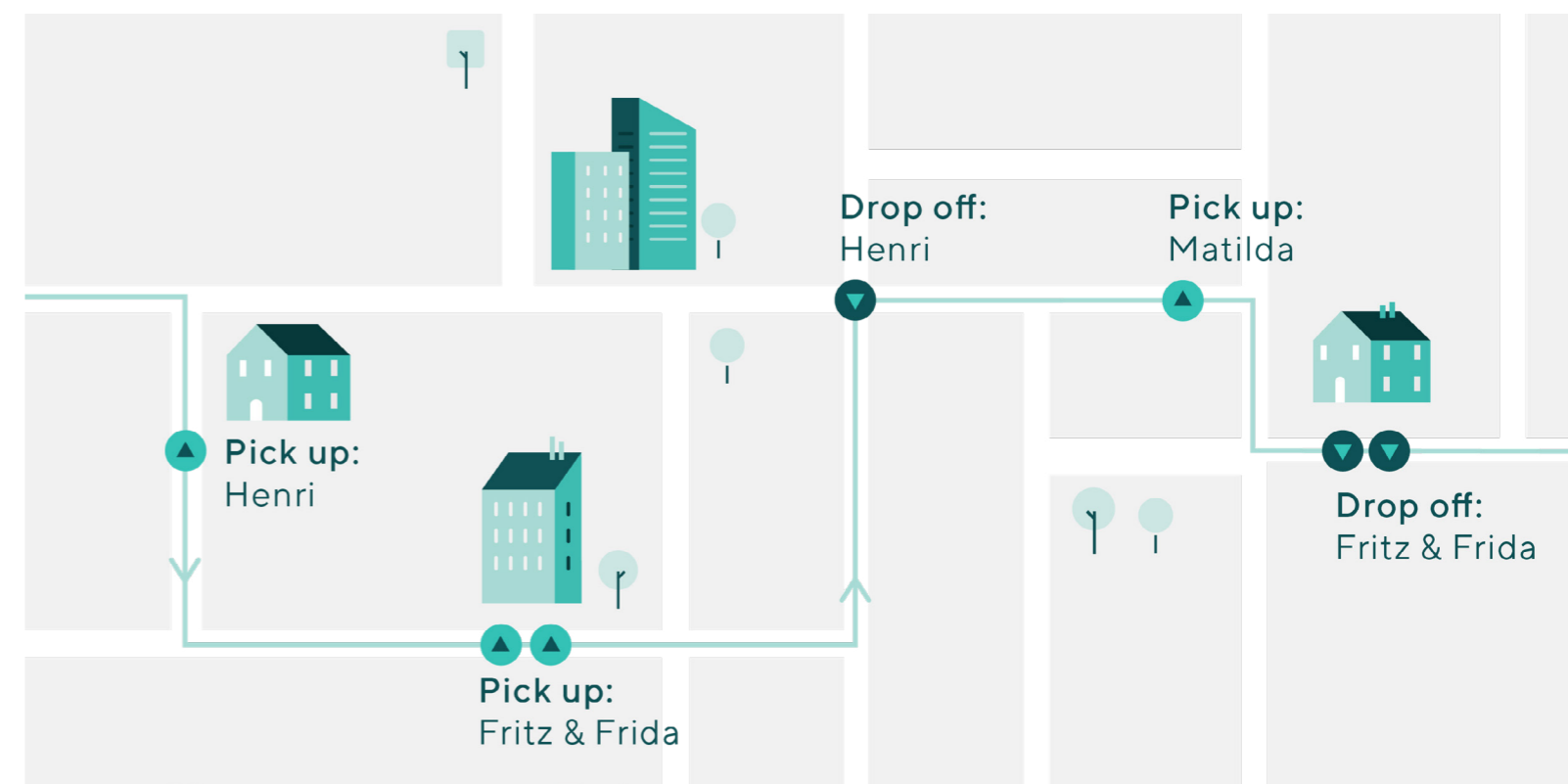
All of these trends are encompassed in ridepooling technology. Ridepooling hits the right note with last-mile services, higher quality and individualized public transport service offers, catering to customer needs, digital interfaces, and, in many cases, with electric and barrier-free vehicles - all at the same time. And ridepooling opens up the opportunity for PTOs to react flexibly to regional changes for the first time. New residential areas can be connected spontaneously, and the success of the services can be monitored and corrected almost hourly with the help of transparent data.

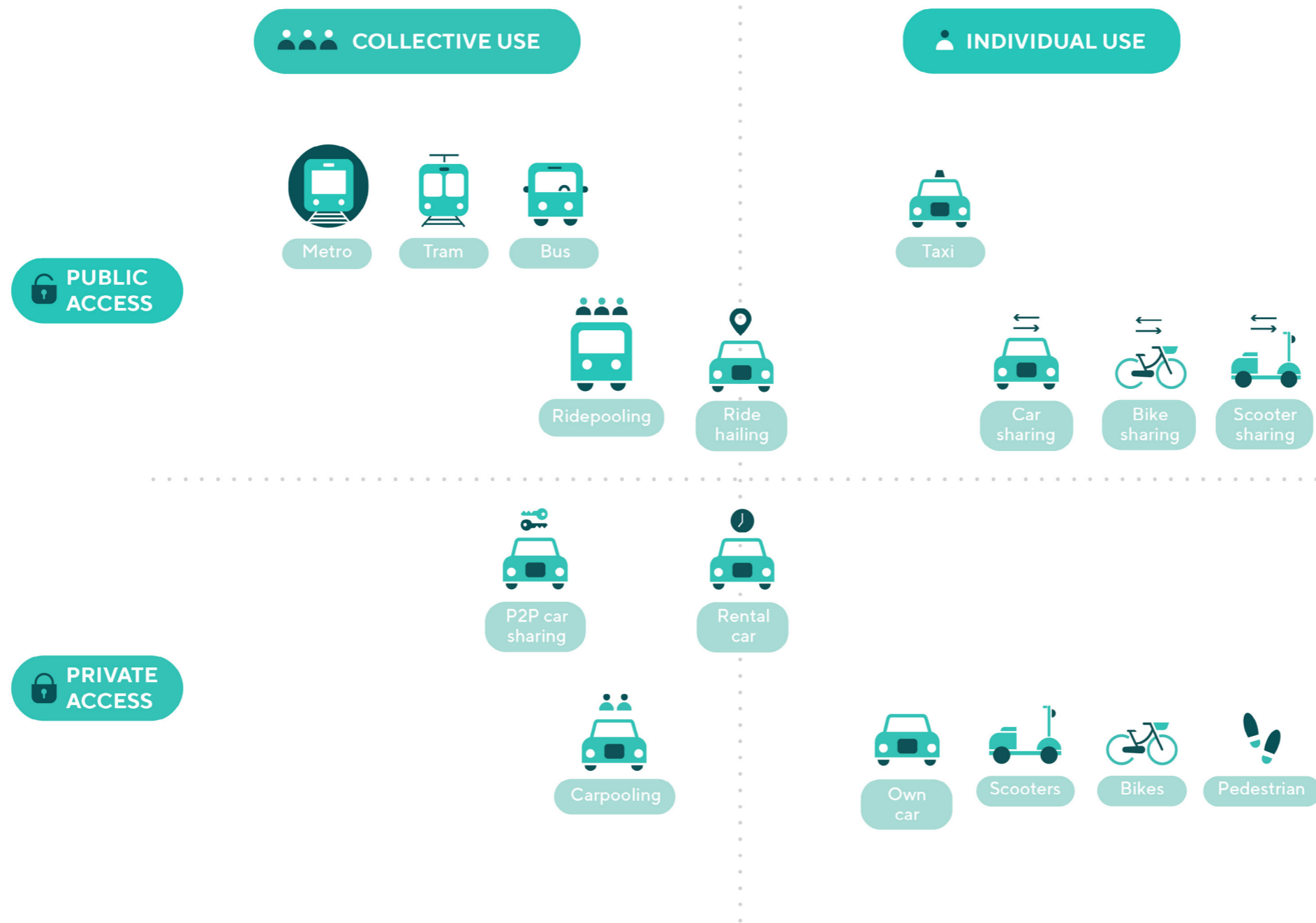
With a demand-based, digital approach, ridepooling breaks down inefficient structures and optimizes existing offers. When booking, each passenger can individually determine

the pick-up time, starting point and destination and is assigned to a free vehicle by the system. At the same time, similar requests coming in via the app are checked. The algorithm distributes the passengers among the vehicles in such a way that detours in each journey are kept to a minimum.

This combination of characteristics has made ridepooling one of the dominating innovation topics in the public transportation industry in

recent years. It has been significantly represented at mobility events, many publicly funded research groups have been formed, and a growing number of technology providers have been racing to develop the best product market fit in order to secure a favourable market share with this emerging trend. Currently there are over 270 active ridepooling projects² in the world, most of them having launched in the last three years in Europe and the United States.





The graphic shows an overview of the different mobility modes, comparing collective and individual mobility on the one axis with public and private access on the other. Ridepooling can be seen as a form of public regional transport situated at a position between collective and individual use.



Benefits of closing the mobility gap

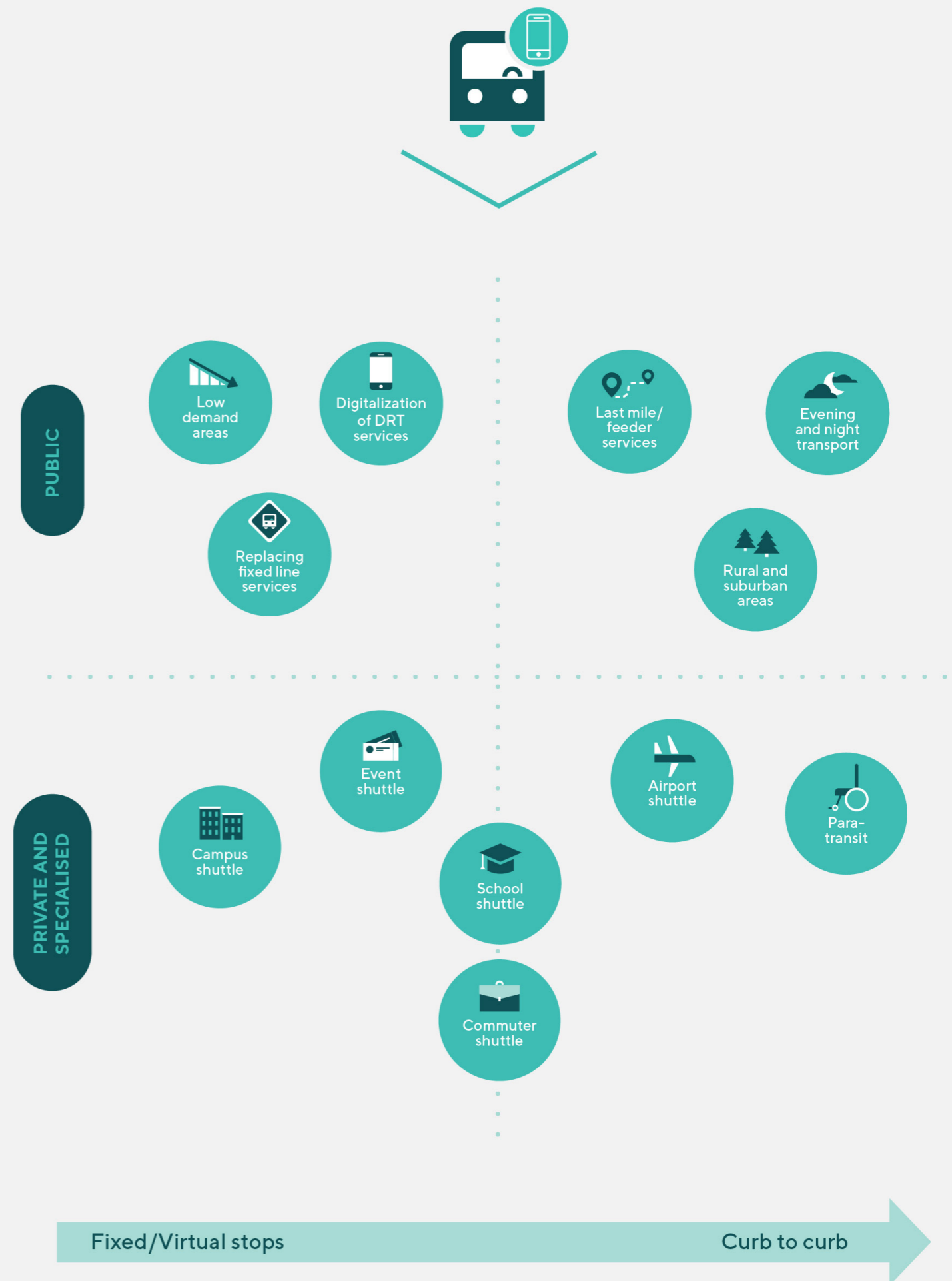
Many existing mobility solutions are either highly efficient or highly flexible.

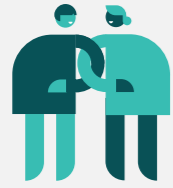
However, there are many use cases that remain underserved in the “mobility gap” due to restrictions by time, location or transport mode. On-demand ridepooling can fill this service gap by complementing existing public transport solutions or creating specialized services.

As shown on the right, there are countless varieties for implementing

ridepooling as a strong and sustainable solution within an existing PTO business model - or establishing it “from scratch”. In the following we will discuss how the introduction of ridepooling solutions also brings many benefits that strengthen a holistic approach.

When on-demand ridepooling becomes a seamless addition to these various services, it can bring social, economic and environmental benefits to our society.





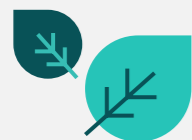
Social benefits

Ridepooling can bring a significant improvement to the lives of people with disabilities. We have replaced paratransit services, requiring two weeks' notice, with on-demand services with a maximum 15-minute waiting time. Ridepooling can provide access to residents who had no alternative before. A great user experience is attracting more public transport passengers. Additionally, ridepooling can make living in remote areas or without a car more attractive.



Economic benefits

The travel time is more efficient, and so is the efficiency per car. Pooling the trips of different people leads to gains in public space, and the costs per ride are reduced. Ridepooling establishes new work locations and after installing autonomous vehicles, costs can be significantly reduced and efficiency further increased.



Environmental benefits

The total vehicle kilometres in peak hours can be reduced by over 50% in metropolitan areas. 52% of people would leave their private cars at home for ridepooling.³ CO2 emissions can be cut by almost 70% when running on electric fleets.

Urban planners and transport companies are aligning their concepts.

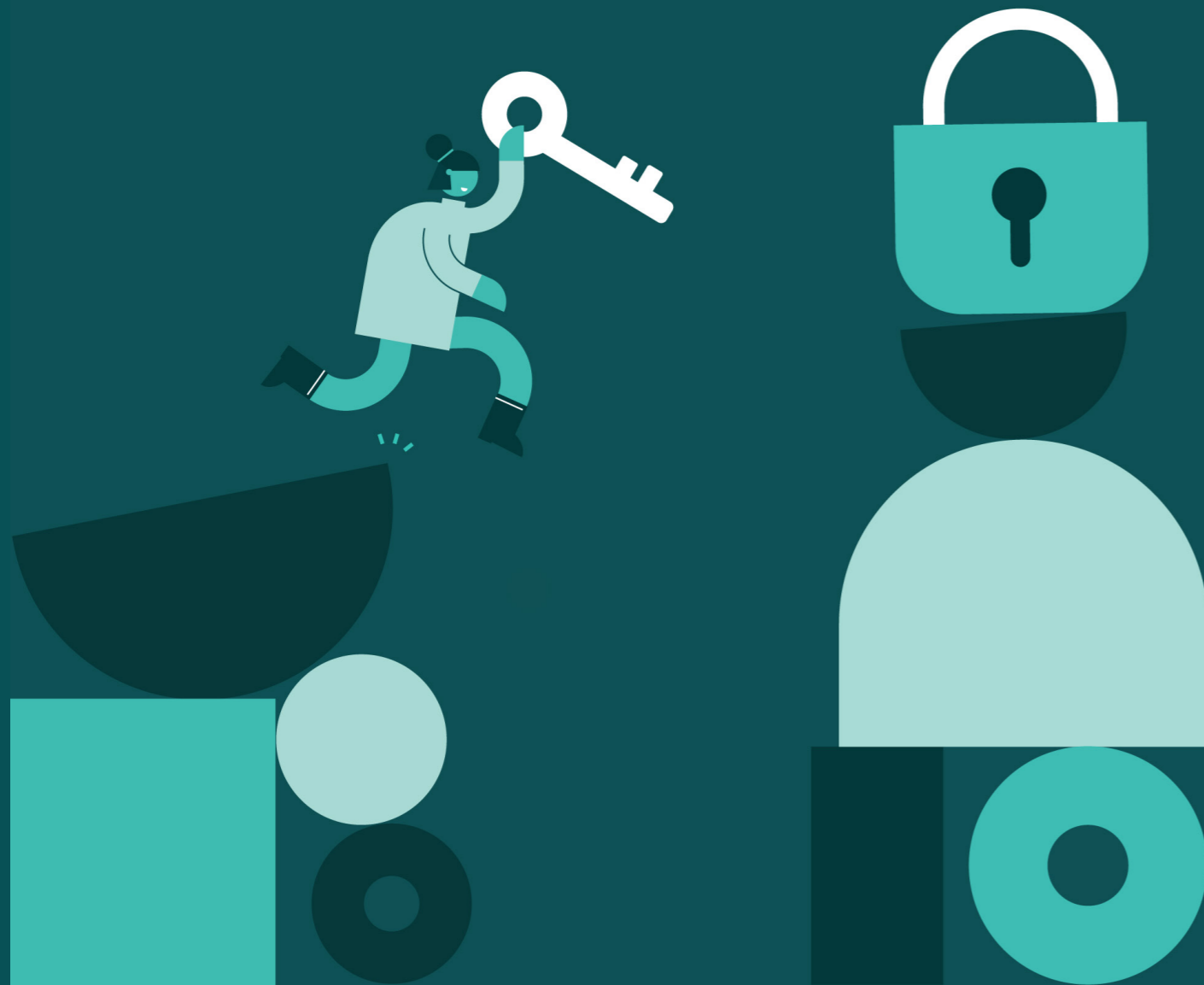
The total vehicle kilometres in peak hours can be reduced by 55% in metropolitan areas⁴, which means regaining space for people and increasing residents' quality of life. Extending mobility options to more people enables access to employment, which contributes to economic growth.

While the five-minute frequency can be achieved in many high-density areas with fixed line services, only

flexible and on-demand services can make this a reality in lower-density areas, especially at the outskirts of the city. Our customer Ingo Wortmann, Chairman of the MVG Management Board - the public transport company of Munich - installed the goal of a ten-minute reach to every kind of public transport⁵ as his strong vision for mobility.

Challenges:

The key barriers



To understand the reason for the discrepancy between the perceived and true potential value ridepooling services can offer, we have identified three major barriers that cause hesitation and hinder the scaling of ridepooling projects.

1. Incompatible regulation

Currently in Germany, but also in many other European countries, there is no existing policy or regulation dedicated to ridepooling services. New services fall either under public transport, characterized by fixed routes and timetables, or under taxi services, characterized by a high degree of regulation and flexible routes, but without the option of sharing rides. This has led to operators applying for licences that are unsuitable for ensuring the efficient operation of ridepooling services.

Within a short time, there will be a new law in Germany that includes a dedicated regulation for ridepooling services. This important first step gives ridepooling legal certainty while guaranteeing services of public interest without neglecting aspects of safety and sustainability. The new law enables mobility to be shaped to include all externalities on a fair market for all players. Once these options are fleshed out in an eco-friendly and socially fair way, people can make sustainable decisions.

For this, ridepooling services will ideally emerge from public transport companies as an integral component of a public transport system. And when the true cost of transportation is allocated to the different modes of transportation, ridepooling will be seen as much more attractive compared to private cars.

In Germany, around 90% of ridepooling services launched by the public sector have a fleet of less than 15 vehicles.

2. Innovation stage

While there is a growing interest and the potential for ridepooling market growth, the lack of commitment to run fleets and operating areas that are large enough remains a key barrier in proving the full value of ridepooling. On-demand services are not necessarily new in the European transportation market - Germany has a substantial history with call-a-bus services in rural regions. But the flexibility and reach of these services, enabled by rapid digitalization and the spread of smartphones, is indeed something new.

In Germany, around 90% of ridepooling services launched by the public sector have a fleet of less than 15 vehicles.

To put this in perspective, there are

about 8,000 taxis and 1,400 buses in Berlin.

While these pilots are sufficient to understand the basic operational framework of running ridepooling operations, they are way too small in scale to prove the potential benefits. While it is widely accepted that newly introduced fixed line services might need a few years to establish themselves in the public consciousness, ridepooling projects are expected to deliver results within the first 12 months of a pilot system with five cars.

3. Lack of a holistic business model

One of the biggest barriers to scaling ridepooling projects is the lack of a holistic socio-economic evaluation

of the business models. The cost recovery ratio is often the main input factor to evaluate the feasibility of a new ridepooling service. While this is a valid business approach for private mobility services, the public sector has a much more complex role in providing mobility to citizens. There are wider socio-economic benefits involved in ridepooling that go beyond the recovery of costs. Of course, on-demand ridepooling includes cost-savings on the following:

- Removing the need to build and maintain bus stops (€22,000 to €63,000 per bus stop).⁶
- Reducing the need to build and maintain parking infrastructure.
- Saving on operating and maintenance costs by managing vehicles, staffing and procedures more efficiently. This means, for

example, maintaining one fleet for different mobility options, i.e. adding vehicles to the service when there is high demand at certain times of the day and using the same vehicles as a flexible night bus system.

But apart from cost-savings, the wider tangible economic value gained from ridepooling services should also be considered in the evaluation of the service feasibility:

Fixed line services: By replacing underutilized fixed line services, public transport companies can improve utilization, in turn gaining new customers and new revenues.

Dynamic pricing: The flexibility of offering small vehicles only when needed and adjusting the price according to service type can maximize revenue while meeting additional demand.

Moreover, the intangible wider socio-economic value gained from ridepooling services should not be overlooked.

For example, less parking infrastructure means more green space for recreational purposes; replacing underserved fixed line services ensures accessibility for everyone. Real-time data enables optimization and better understanding of travel behaviour in the future. The introduction of a ridepooling service is only justified if the costs are lower than that of a fixed line service. We see a clear need to define new approaches in which larger societal benefits are represented in the business cases of new mobility projects.

Ridepooling as a system-relevant offer during Covid-19

The Covid-19 pandemic has brought a range of challenges globally, especially for the public mobility industry. Lower demand as global lockdowns shut down all non-essential parts of daily life has put a financial strain on mobility providers. Even with an ease in restrictions, the use of services has only recovered slowly.

Our customer SWMS (Münster) didn't stop their ridepooling service "Loop", gaining some really interesting insights in the process. A weekly utilization rate of 40% on average throughout the lockdown and more than 2,500 completed trips per week are a clear indication that Loop has become a key part of life for residents in the sense of a public service. Use has increased in the

morning and evening hours - an indication of passengers working in system-relevant professions. The increased use of pre-booking supports these assumptions as well, with around half of the total completed rides being booked in advance.

At the start of the pandemic, the overall demand illustrated by completed rides dropped by 50% on average. Providers had to eliminate some available bookable seats in every vehicle due to new restrictions and applied health concepts. Thus, vehicle productivity dropped from 4-5 passengers per hour per vehicle, to 2-3 passengers and only one-third of the rides were actually pooled.

Pre-booking continued to be a strong feature throughout the pandemic, with half of the rides being pre-

booked. Several projects in small/medium-sized cities launched during the pandemic, and were actually positively perceived and directly adopted by passengers. The utilization rate was around 35% and features such as pre-booking and telephone booking provided an extra layer of security for passengers.

Our conclusion: Shared mobility is ready to be launched during a pandemic and beyond if pandemic regulations are integrated into the service (e.g. a hygiene & safety concept with regular disinfection of the vehicles, including dedicated training sessions with the drivers/dispatchers with regard to the new concept and communication) and the physical payment methods are changed to digital payment only.



Resolution: Break through the barriers



Looking ahead, we are certain that ridepooling will be a driving force in the future of mobility if it's given the appropriate framework to develop its full potential. We've defined four main points that can help overcome the key challenges of implementing a new ridepooling service and unlock the full value of the technology.

Improve efficiency with versatility

Efficiency plays a central role in the success of a new ridepooling service and is largely influenced by the fleet utilization. To find further ways of directing demand to existing fleets or vice versa is therefore a core element in increasing the value impact of on-demand ridepooling.

A mixed fleet allows an increase in overall profitability.

Today, an aggregation of services only happens at the demand (end user) side of a service (multimodal/intermodal journey). Users can choose and combine their modes to reflect their preferences, and through this, optimize their own journey. But only in some rare cases does the same happen on the supply (fleet) side of a mobility service.

In other words, the real uncaptured value lies in increasing the vehicle uptime across all fleets!

For ridepooling, this means that complementary use cases can be integrated into one fleet: Medical transport, school transport or corporate mobility can become additional application segments, making the service more versatile. 19% of the workforce in the EU, or 43.3 million people, are engaged in night work.⁷ 50% of students travel more than 5 km to school

or university.⁸ A lack of transport solutions remains one of the top three reasons why patients miss a doctor's appointment.⁹ Many mobility services are conventionally seen as a stand-alone system at the expense of efficiency. By combining these trip purposes and fleets, we can maximize efficiency and also achieve a great customer experience.

Building on existing taxi fleets can boost on-demand ridepooling

systems from the start, as this provides flexibility while reducing risk and investment. Combining these use cases is technically very easy, without requiring any adaptation of the vehicle itself.

In addition, extending the utilization to new business models such as logistics (e.g. first/last-mile delivery) or vendor-sponsored transport (e.g. reverse delivery), and new revenue streams, as well as new user groups

(e.g. tourists) - all while bundling other transportation modes into subscription-based ticketing - can boost the efficiency of the service.

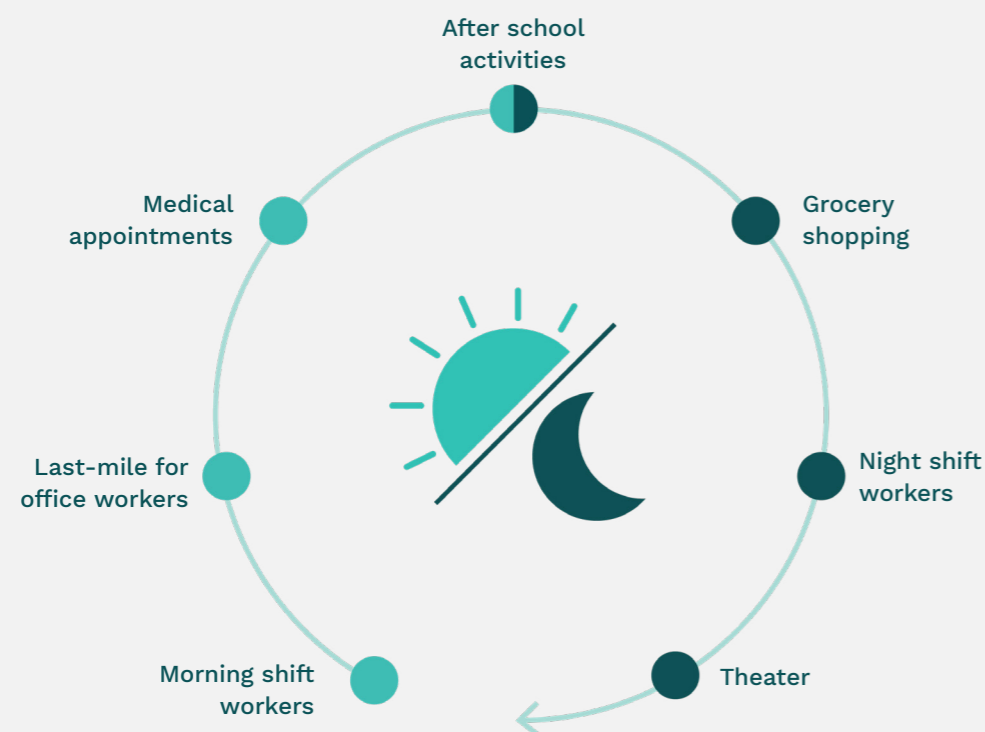
One way of maximizing the potential of a new ridepooling service is identifying and partnering with local businesses to create meaningful cooperation. By including local restaurants and shops in the grid of virtual stops of an on-demand fleet, we can allow locals to book rides from and to these points of interest. This enables the on-demand ridepooling system to be deeply integrated into the local economy, helping to increase acceptance of and identification with the system.

Data-based service optimization

Data can enable a resolution of the barriers mentioned by providing insights that support success stories against potential issues, while simultaneously promoting

best practices and ridepooling enhancement. After all, solid strategies can only exist through a data-based analysis that supports action plans with data learning and predictions on how to optimize the service for success each time. Data can be used intensively in two stages of the ridepooling's product lifecycle: a) ex-ante and b) ex-post.

a) Data is used to plan and predict operations. Through geoinformation tools, operations are visualized and predicted using statistical modelling and machine learning. This prediction strategy allows service planning to take place, even before the wheels hit the road. Virtual ex-ante simulations identify public transport gaps, provide a ridepooling use case and ensure that the service and the relative investment will pay off (at door2door, all of the above are carried out through our product "Insights").



Through data, we can prove the value a ridepooling service brings to citizens.

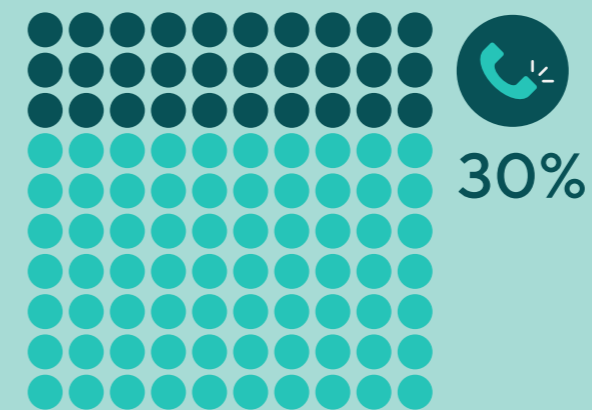
b) Once real operations start, data is collected to analyze and optimize the service. Ridership and performance data (KPIs) can be utilized to understand the service and plan its optimization with a data-based strategy. Additionally, predictive modelling can support such optimization analysis. The demand and supply of a service provide a broad landscape for experimentation (at door2door, all the above are carried out through the Analytics Platform, in collaboration with the d2d Data Analysis Team and their Consultancy Optimization Handbook).

Furthermore, the end user experience can be improved by opening a direct channel between the end user and the provider. In this process, passenger feedback is collected and taken into consideration, supporting the customer-centric approach of the mobility service. Finally, the ridepooling product as a whole

needs to utilize external public transport data as well, referring to the landscape of urban life, mobility trends and the smart direction of the respective city plan. This enables ridepooling to be integrated within data from the urban world, coexisting organically in its environment.

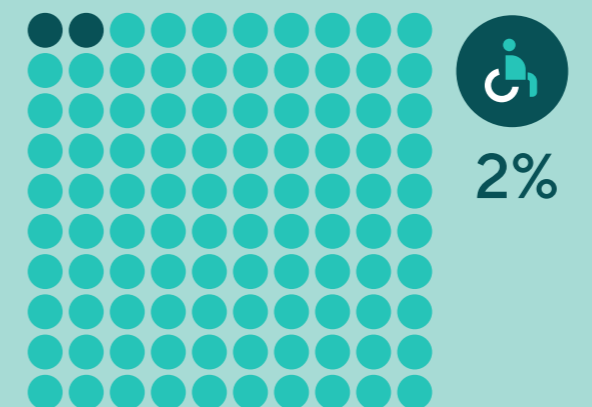
Through data, we can prove the value a ridepooling service brings to citizens. More specifically, based on our experience and real ridepooling operations, we present a set of metrics illustrating the added value and the social impact of ridepooling.

Accessibility and inclusion metrics:



Telephone booking:

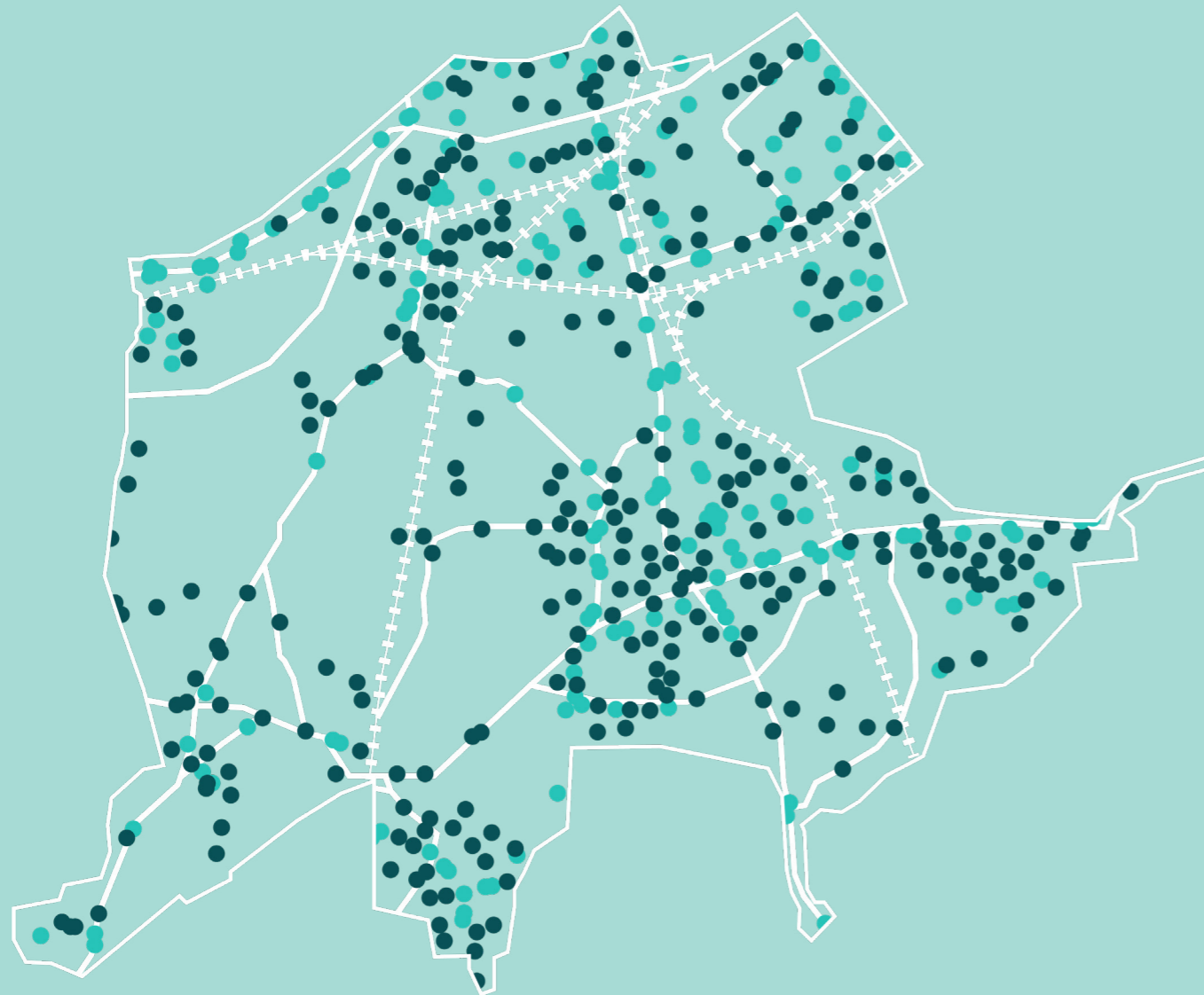
30% of all bookings are carried out with landline phones. We observe that the smaller the city size, the higher the telephone booking usage, even exceeding 30% in some cases. Maintaining classic channels to book a ride for non-tech familiar audiences has proven to be important.



Wheelchair and screen reader feature:

On average, 1-2% of all bookings in Germany include a wheelchair space. This means that nearly **2%** of all wheelchair users in Germany are taken into consideration, and that their accessibility to innovative mobility matters. Furthermore, the ridepooling product offers a screen reader feature for users with vision impairments.

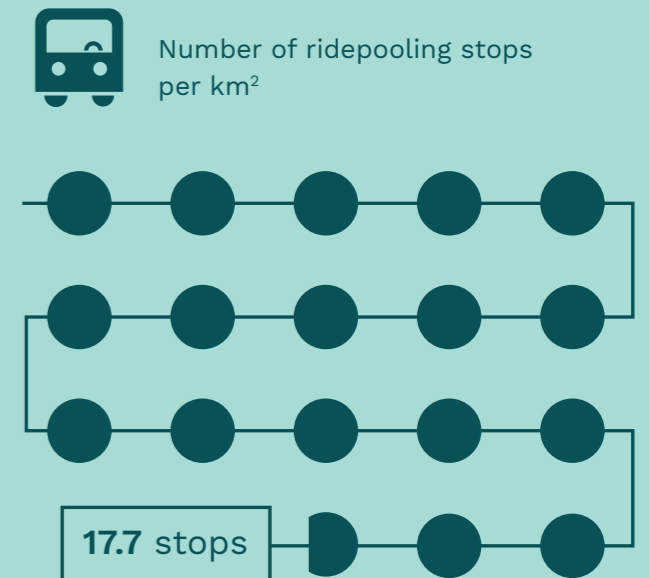
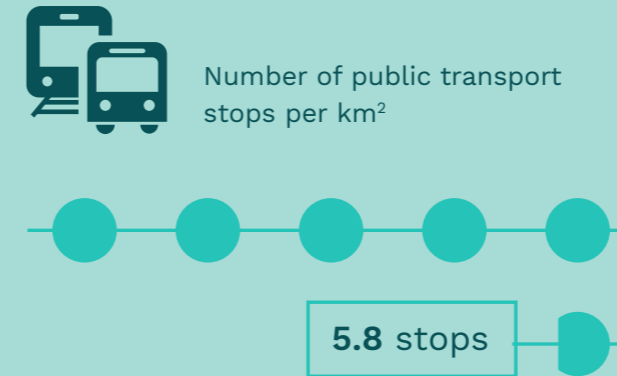
Value impact of ridepooling:



- approx. **230** existing bus stops
- **470** additional virtual stops

Accessibility to public transport (PT):

With the addition of virtual stops, on-demand ridepooling tripled the PT coverage of the area. Specifically, in Münster, the network was enriched with **470** virtual ridepooling stops, in addition to the **230** existing PT stops.



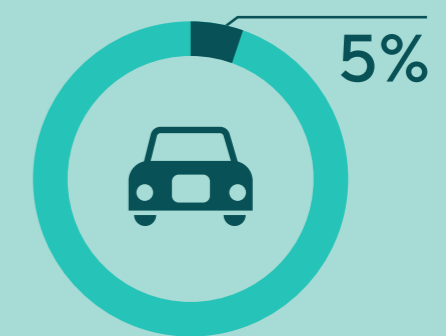
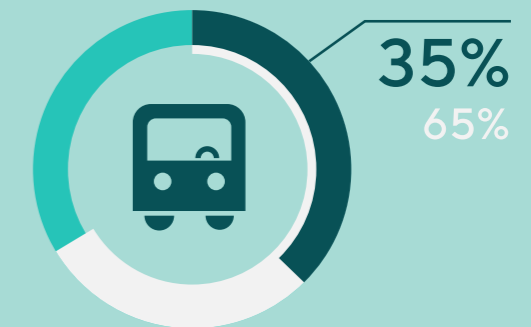
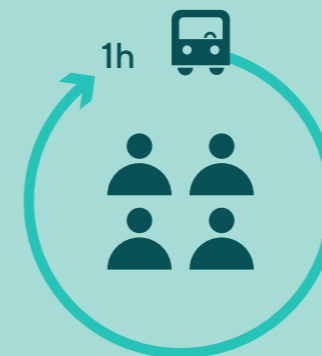
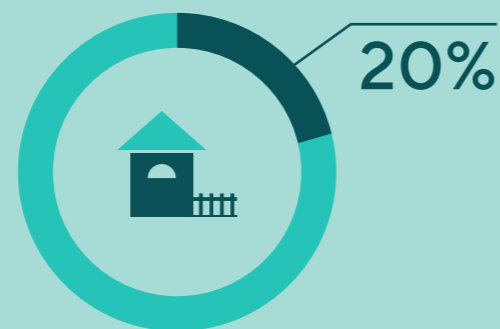
Density of stops per square kilometre:

In Münster, the density of ridepooling stops reaches 17.7 stops per square km, whereas classic PT remains at 5.8 stops per square km. Ridepooling offers citizens **three times higher density** in terms of available stops.

Pooling based on ride:

On average, pooling reaches 65% for big cities, 35% for small/medium-sized cities and 20% for rural areas in Germany.

In big cities, nearly two-thirds of our rides are shared. This means that two-thirds of our passengers are being pooled in these cities. In small/medium-sized German cities, one-third of our passengers are being pooled, whereas in rural areas in Germany one-fifth of the passengers using our service are being pooled.



Vehicle productivity:

On average, 4 to 5 passengers per hour per vehicle are transported with ridepooling in normal times. With private cars, on the other hand, ridership per hour per vehicle lies on average at 1 passenger.

Note: due to the pandemic, the number of bookable seats and the transported passengers per hour per vehicle were reduced to 2 to 3 seats.

Utilization:

During pre-pandemic times, vehicles transported at least 1 passenger on average **two-thirds of the time (65%)**. Due to the pandemic, utilization dropped, with vehicles transporting at least 1 passenger more than one-third of the time (35%). However, it is known that private cars are utilized only 5% of the time. Comparing utilizations shows that ridepooling adds more value in terms of how vehicles are used.

People leave their car at home when they learn that the ridepooling offer is a real alternative in terms of availability and costs.

Currently, there are countless promising approaches in which gaps in the mobility offer can be closed through efficient ridepooling based on data. On the one hand, hotspots are easy to identify for temporarily deployed ridepooling services. A hotspot refers to certain locations that generate an increased demand in mobility at certain, predictable times. These hotspots can be quickly and precisely pinpointed through data analysis and offer an outstanding opportunity to quickly establish attractive and successful ridepooling services.

Another huge advantage of applied ridepooling is the possibility of integrating certain virtual stops. It is not necessary to wait for extensive construction work and administrative approvals - by using barrier-free vehicles and stops specifically

designed to meet customer needs, a high-quality mobility service can be introduced ad hoc.

Several ridepooling projects under our guidance have also proven that relatively reliable predictions of changing user behaviour are possible right from the start of the service.

People leave their car at home when they learn that the ridepooling offer is a real alternative in terms of availability and costs.

In addition, the algorithm can be used to ensure that where good public transport is available, it remains the cheapest option. Those who still want to use ridepooling in these places will pay more accordingly. This prevents the individual modes in the transport system from cannibalizing each other.

Deep integration into public transport

To provide a seamless, easy-to-understand and door-to-door travel experience, a ridepooling service should be integrated into all levels of the public transportation network and encompass the entire travel chain, including route planning and booking. A single login for all mobility offers reduces entry barriers and creates a holistic experience. Intermodal travel chains enable seamless travel experiences for passengers and leave no gaps in the mobility offering, all while still staying efficient. This not only enhances the user experience, but also strengthens communities and allows sustainable accessibility.

Overall, traffic planning expertise and data-based planning and simulation must serve as the basis

for a successful and sustainable on-demand service. In terms of tariffs, there are many options on how to integrate a ridepooling service into the public transport offering.

- Standardization of tariff models for ridepooling
- Bundling with other transportation modes, e.g. in subscription-based ticketing models
- Larger buses and a fleet with many vehicle options, from cars to mini-buses





8,400

on-demand
transport shuttles



50%

reduction in
private cars

We calculated a business case for 2030:

Taking the city of Munich as an example and building on the city's existing taxi fleet (today there are 3,400 taxis), roughly 5,000 more on-demand public transport shuttles would be needed to reduce the number of private cars by nearly 50%. By pooling passengers with similar routes, there would be 360,000 less private cars on the road, reducing the annual number of passenger kilometres caused by private cars by around 3.8 billion.

This would lead to ca. 7.5 square kilometres of new space due to less parking space needed (1,500 football fields) and 140 hours of time gained per year per driver due to zero congestion. The city can steer the entire urban traffic, managing supply and demand

with an operating system, thereby creating an economically, socially and ecologically sustainable business case.

A major advantage of on-demand ridepooling is the ability to offer several business cases in one vehicle fleet. The vehicles can operate as a premium service in areas where public transport already exists, or the same fleet can provide services for the first time in regions without public transport. The way to avoid cannibalization while simultaneously ensuring profitability is smart pricing, which should always be included in the booking system. Smart pricing means: If public transport is available that is comparably fast or faster than the ridepooling offer, then ridepooling will be priced more expensively. If not, it will be offered at the same conditions as a normal bus ride.

Funding programmes

“Incubation support” by public funding is needed for the start of a mobility service. The good news here is that it is already available. Political stakeholders - whether at the EU, national or federal state level - have recognized the signs of the times, not only by reforming the Passenger Transportation Act, but also by providing further funding to optimize new ridepooling services. The new legal certainty of ridepooling services means that these very services, should they be part of the public transport system, can also be financed by federal funds, which will reach 2 billion euros annually.¹⁰

Likewise, services can be supported by other subsidies if they improve the services of public interest. The

German federal states in particular have recognized this and are trying to improve mobility, especially in rural areas, by replacing bus lines or digitizing demand-responsive transport (DRT) systems. In the same way, holistic concepts, such as smart city projects, can promote the mobility of tomorrow. In the coming years, several billion euros will flow into new pooling transport models through various EU funding programmes, member states and federal states.¹¹

Aspects such as better demand prediction, the combination of pooling with e-vehicles or even autonomous vehicles, and better integration of public services with electricity, hydrogen and mobility are of particular interest.¹²

An outlook to the future

On-demand mobility has the potential to create an integrated, connected and orchestrated mobility future, bringing economic, social and environmental benefits. The fact that legislators finally recognize that ridepooling is an important mobility solution for a climate-friendly future is an important first step. But government funding programmes are only the prelude to a technical development that can no longer be stopped. Nevertheless, it is important that the signal has been given: Mobility is worth public money.

Fast-paced developments around autonomous driving, electric vehicles, pooling and the networking of things can no longer be stopped in terms of their comprehensive implementation.

Ridepooling is in a promising position to maximize those benefits when it:

- is seamlessly integrated into public transport, turning fixed

line services into mobility - on-demand, anywhere and anytime

- focuses on improving the user experience by utilizing real-time data and analytical tools
- enables a modal shift from private vehicles and adds new passengers to public transport
- provides abundant data and insights for setting a policy framework deploying purpose-built autonomous vehicles, which will significantly increase efficiency and cost reduction.

Bold visions like the NEOM project in Saudi Arabia show that cities will become places for people again. Regaining urban areas is possible if we shape mobility alternatives to overcome the private car. This means planning for innovation in high-speed transit and on-demand shared mobility, enabled by autonomous solutions and a ubiquitous digital



infrastructure. The livability of our urban environments will prioritize walking, cycling and personal electric mobility devices. These will be on an urban scale, enhanced by access to high-speed, backbone public transit services that connect all neighbourhoods. Projects like NEOM will introduce a new model for urban sustainability and build cities from scratch as places that focus on setting new standards in community health, environmental protection

and the effective and productive use of technology. Ridepooling is the ideal complement to all these social developments, as it can be perfectly integrated into existing systems and unfolds its full potential ad hoc as soon as providers decide to install large vehicle fleets and service areas.

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Endnotes

¹ <https://thetyee.ca/Opinion/2018/10/17/Five-Minute-City-Better-Vancouver/>

² <https://lukas-foljanty.medium.com/on-demand-ridepooling-market-2020-recap-71a229f2e7b9>

³ <https://www.academyofurbanism.org.uk/the-fifteen-minute-city-five-minutes-of-fame-15-minute-cities-towns-and-neighbourhoods/>

⁴ <https://www.abendzeitung-muenchen.de/muenchen/mvg-chef-ueber-oepnv-plaene-auto-verbot-bei-voller-innenstadt-art-476215>

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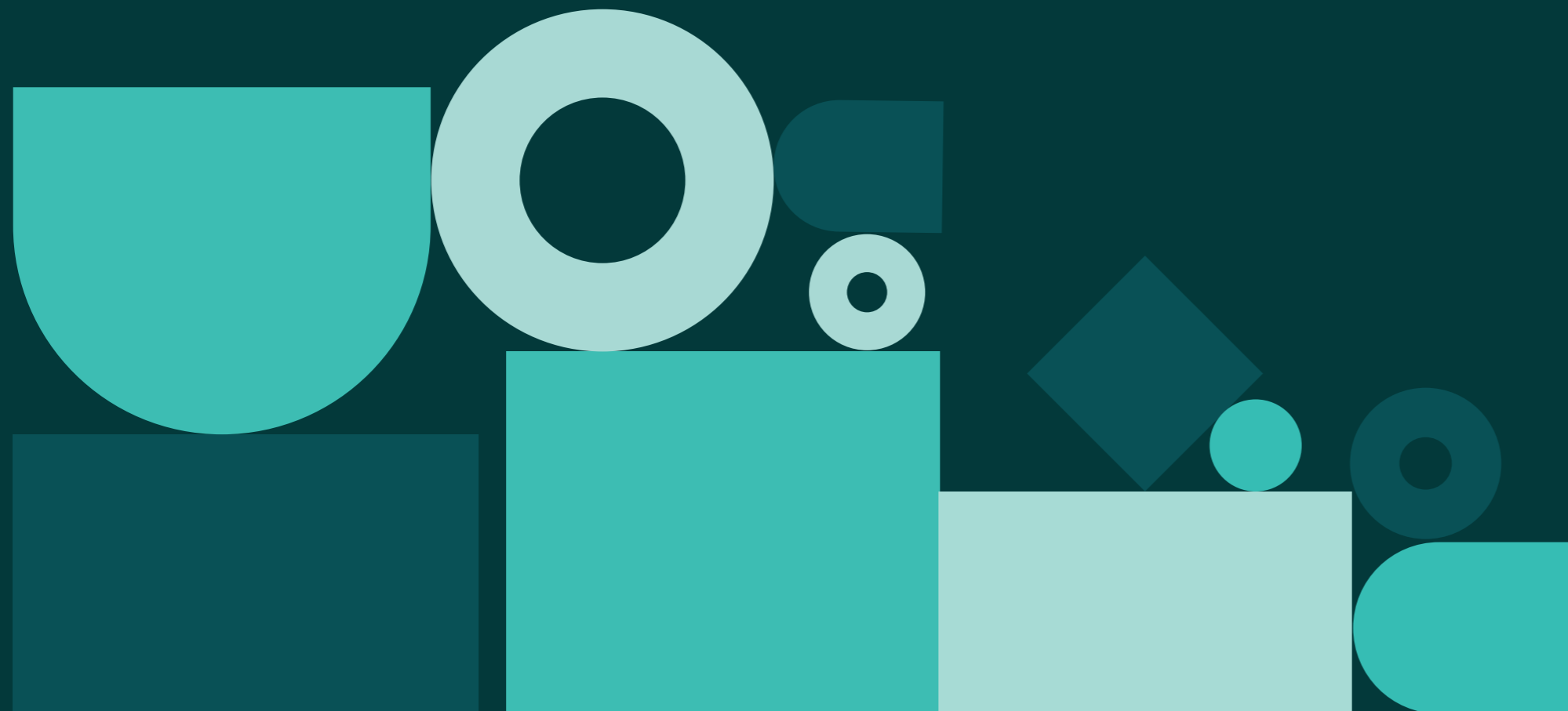
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About door2door

door2door is the leading innovation partner for the next public transport. In urban areas and in the countryside, in the evenings and on weekends or as a feeder service: We identify the gaps in your mobility service and supplement the network with an on-demand bus that combines the flexibility of a car with the efficiency of traditional local transport. Based on our innovative ridepooling

technology and controlled by our intelligent algorithm, journeys with a similar destination are efficiently bundled, sustainably expanding your route network. In this way, you can provide a nationwide service in the sense of public service, which brings new users to public transport and increases the profitability of your mobility offer.



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