mobility institute berlin

Beyond the immediate crisis:

The SARS-CoV-2 pandemic and public transport strategy

A Guideline for Action

The Mobility Institute Berlin (mib) is a consulting and research firm supporting the transformation of urban mobility. Our activities are driven by one mission: To make cities more liveable by enabling more likable mobility. Together with our clients from politics, administrations, private and public companies, we develop clear visions for a sustainable future of the mobility sector. Based on such visions, we formulate strategies and implementation roadmaps. Our work is evidence-based, building on systematic data analytics and innovative tools. Furthermore, we believe that proactive change management is key to successful transformation. It is our conviction that public transport is the backbone of a comprehensive sustainable mobility system that also includes pedestrians, cyclists, cars and new mobility services.

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EXECUTIVE SUMMARY

SARS-CoV-2[ii] has shocked the world. Urban mobility is no exception. *#stayathome* is not only trending on social media, it is what most people do. With passenger numbers down by up to 95% in some European cities, public transport has been hit especially hard. Public transport authorities and companies are doing everything they can to tackle the immediate operational challenges that the crisis is confronting them with.

As we move from immediate crisis into the next phase of the pandemic, however, longer-term strategic considerations come to the fore. This paper aims to clarify the medium- and longer-term effects that the SARS-CoV-2 pandemic will have on urban mobility and public transport strategy. We build on our reading of the most recent scientific debates on the pandemic, expert mobility and public transport knowledge, and targeted interviews with public transport operators, authorities and experts as well as with new mobility players.

Our major findings are:

The Pandemic

The current crisis is only the beginning. The SARS-CoV-2 pandemic might last for several years.

We are approaching a second pandemic phase. This calibration phase might last until the second half of 2021.

Until then, we might experience repeated infection waves and a back-and-forth between periods of more and less restrictive counter measures.

A full lift of restrictions remains unlikely until the pandemic concludes. For this to happen, an effective vaccine needs to be developed and widely distributed.

Mobility Behavior

While mobility demand will rebound after the initial crisis phase, it is likely to remain below pre-crisis levels at least throughout the calibration phase.

Given the back-and-forth of restrictions, mobility demand will remain volatile throughout the calibration phase.

Given its comparatively high perceived (and actual) infection risk, many people might continue to avoid public transport over the coming months.

People are likely to get used to a more flexible way of choosing different trans-port modes from day to day.

Public Transport Strategy

Beyond the current crisis management, public transport authorities and companies need to formulate long-term strategies.

It would be a mistake to sideline or halt strategic initiatives just because they do not directly contribute to crisis management.

We find that five particular initiatives have a crucial role to play in navigating the pandemic in the years to come.

These initiatives are public transport offer expansion, multi-modal integration, simple and flexible pricing, digitalization and building agile organizations.

The pandemic: Crisis, calibration, and conclusion

It seems plausible that the SARS-CoV-2 pandemic will last for several years:

In an initial **crisis phase**, governments across Europe have tried to suppress the spread of SARS-CoV-2 by substantially restricting social and economic life. These measures were essential in preventing an uncontrolled spread of the virus. It is important to understand, however, that they mark the beginning of the SARS-CoV-2 pandemic rather than its end.

Many countries are already approaching a second, **calibration phase** that might last until the second half of 2021. While measures are going to be relaxed during this phase, we are likely to see continuing efforts to mitigate the spread of the virus, such as softer forms of social distancing or a continuing ban of large public events. Moreover, it is likely that we will experience recurring waves of infections, during which more restrictive measures will have to be re-installed.

The pandemic will enter a **conclusion phase** only after a SARS-CoV-2 vaccine becomes widely available. Even then, however, we will not return to "pre-crisis normal". SARS-CoV-2 might never be defeated entirely, and we might continue to see shorter and locally specific mitigation or even suppression. Moreover, the pandemic might lead to lasting changes in terms of the degree of digitalization of peoples' lives (e.g. home office and e-learning) as well as with respect to hygiene norms and mobility behaviors.

A pragmatic approach to scenarios

The introduction of this chapter outlines what we consider a plausible scenario on how the SARS-CoV-2 pandemic might evolve. Based on our best understanding of epidemiological and virological research and debate, we further explore this scenario throughout the chapter.

It is important to note, however, that a lot about SARS-CoV-2 still remains unclear. Even though infection numbers make headlines every day, their reliability is low given the great differences in testing across geographies. With respect to the virus itself, furthermore, we do not yet fully understand the effect of rising temperatures on reproduction, the potential for future mutations, or transmission pathways beyond direct human contact.[iii] It is also unclear if existing drugs might be effective in treating COVID-19 or when a vaccine will be available. Political, economic, and societal reactions to the virus bear additional uncertainty.

Suppression	**Mitigation**
Set of strategies that reduce the average number of follow-on infections from an infected person (repro-duction number, also called R) to below 1.	Set of strategies to slow the spread of the virus and to avoid overburdening the public health system. Not necessarily intending to bring R below 1.

Box 1: Strategies to fight SARS-CoV-2

Given these uncertainties, other scenarios are plausible too. A worst-case scenario, for example, might assume an unstopped (or unstoppable) spread of SARS-CoV-2 and some form of economic or even political collapse. While such development cannot be ruled out entirely, the magnitude of problems that society would face in this scenario is likely to render the future of public transport a secondary concern.

A best-case scenario, in contrast, would suggest that SARS-CoV-2 would be eradicated quickly, for example through an unexpectedly speedy development of a vaccine.[iv] In hindsight, the current crisis would look like a very dramatic but short-lived interruption from an otherwise constant story.

Figure 1: Outlook on the potential development of the SARS-CoV- 2 pandemic

The strategic implications of such scenario for urban mobility and public transport would be limited. We will nevertheless come back to the best-case scenario when discussing the strategic implications of SARS-CoV-2. In the following, however, we focus on exploring a scenario that deals with the potentially severe challenges posed by SARS-CoV-2.

Stage 1: Crisis

Despite the sad news coming out of Northern Italian hospitals and other parts of the continent, it is important to stress that Europe has – for now – avoided the risk of an unchecked pandemic. Following the Italian lock-down of March 9, 2020, the great majority of European countries significantly restricted freedom of movement and social interaction. For now, these measures seem to be effective in suppressing (see box 1)[v] the spread of SARS-CoV-2.

Most European citizens seem to go along with government regulations and guidelines. A sense of urgency and solidarity is widely shared. Homeschooling and home office have become a part of the daily life in many households across the continent.

Large parts of the economy have been shut down. Despite the swift reaction of states across Europe and the European Union – announcing support and guarantee schemes worth trillions of Euro – small and medium-sized enterprises are running into cash-flow problems, putting their employees on short-time working or furlough, or laying them off entirely.

Furthermore, current measures might have substantial negative effects on peoples' physical and psychological health. Consequently, the pressure to relax the far-reaching restrictions is growing.

Stage 2: Calibration

After the initial crisis response, we are likely to move into a prolonged calibration phase. The challenge throughout this phase will be to calibrate the response to SARS-CoV-2 in a way that balances epidemiological concerns with economic and societal necessities. While this balancing act will result in a relaxation of restrictions, this will most likely not mean a return to pre-crisis life.

Back-and-forth between mitigation and suppression increases volatility

Calibration is likely to take the form of a back-and-forth between phases of mitigation and suppression. When infection numbers are falling, the current suppression strategy could be substituted by mitigation strategies. Such mitigation would allow a return to a more normal social and economic life. Two recent simulations suggest that mitigation would still reduce social contacts by 25-40%.[vi] Even though this reduction is

far less radical than those 70-75% that the simulations assume for suppression phases, a move to mitigation would not mean a full lift of restrictive measures.[v]

Moreover, recurring waves of infection are possible. Suppressive measures might be re-introduced whenever the numbers of new critical COVID-19 cases exceed certain thresholds. Indeed, already today, countries like Japan, Taiwan and Singapore are experiencing what might be the onset of a second wave of SARS-CoV-2 infections.

The relative length of the suppression and mitigation periods is hard to foresee. One of the abovementioned simulations suggests that, over the coming months, it might be necessary to keep up suppression for roughly two thirds of the time.[v] Given the inherent uncertainty of the current situation, however, this is but one prediction.

The concrete number, length, and intensity of future infection waves remains unknown. It will depend on a variety of factors, such as the impact that higher temperatures will have on the virus, potential mutations that might have an impact on the virus' reproduction rate, the actual number of infected individuals, the development of critical care capacity in hospitals, innovations in the treatment of COVID-19, new testing methods and practices, and the effectiveness of quarantine and social distancing measures as well as the compliance with them.

Reduced compliance and heated societal debate might result in non-optimal measures

While most people in Europe have complied with initial restrictive measures, the fear of the virus might wear off, giving way to growing crisis fatigue. As a result, the degree of compliance with restrictive measures might diminish. This, in turn, would increase the risk of new infection waves.

Moreover, society is likely to become increasingly critical of restrictions, as doubts about their legitimacy and proportionality arise and the economic situation worsens. Consequently, this might lead to policy responses that are suboptimal from an epidemiological standpoint, particularly in countries or regions facing elections.

Continuous economic struggle and uncertainty about public spending

While economic activity may well pick up during the calibration phase, ongoing restrictions and recurrent periods of suppression will create further challenges for small and large businesses alike. The revenue potential of cafes and restaurants, for example, might be reduced significantly by upholding social distancing rules.

A swift economic recovery seems unlikely under these conditions, and unemployment rates might stay higher than before the crisis. It remains unclear if and when economies could return to a growth path.[vii] Depending on pre-crisis conditions, the severity of the crisis, and crisis response, developments might well look very different from country to country.

Furthermore, economic performance could force states and municipalities to re-consider their spending practices. Governments are facing a dual challenge: Economic rescue measures demand massive funds and, at the same time, lowered economic activity and consumption result in reduced tax income. Under these circumstances, states and municipalities will be forced to re-prioritize their spending.

Structural shift towards digitalization with respect to work, education, and leisure

On a more structural level, finally, the prolonged calibration phase might result in helping the digitalization of life to break through. By digitalization we mean the shift from physical interaction to virtual interaction in all parts of life, e.g. work, education, and leisure. The longer the calibration phase lasts, the more likely it will

be that even hesitant individuals get used to home office, e-learning and videocalls with friends.

Stage 3: Conclusion

The development of a SARS-CoV-2 vaccine will be the game changer, signaling the start of a conclusion phase. 70 vaccine projects are currently under way and some initial progress has been made.[viii] Nevertheless, vaccine candidates will have to go through animal testing, clinical trials, and approval, which takes time. Current estimates by the World Health Organization (WHO) and experts suggest that it might take around 18 months before a vaccine will be readily available.[ix]

Even though a few vaccine projects have skipped the animal testing stage and already started small-scale human trials, the 18-month timeline continues to appear ambitious. As Peter Hotez, a leading expert on infectious disease and vaccine development at Baylor College of Medicine, puts it, developing a vaccine in 18 months might be possible only if "all stars align".[x]

Production and dissemination might take additional time.[xi] The resulting delay might depend on production capacities at the time of approval, the country in which the vaccine is developed, and arrangements to share it among states. In addition, limited availability might require a sequenced approach to vaccination. High-risk individuals and employees in highly exposed occupations may be vaccinated first, while the broader public would have to wait until enough vaccine doses are available.

Both economically as well as societally, the conclusion phase will signal a slow recovery. However, some aspects of life might have changed forever. First, the abovementioned digitalization is likely to remain, having an impact both on the structure of the economy as well as on daily habits and routines. Furthermore, new societal norms are likely to stick. Welcoming hugs and handshakes, for example, are not certain to survive the pandemic. Extensive handwashing, sneezing into one's elbow, or wearing face masks in certain situations might also be here to stay.

Altogether, the SARS-CoV-2 pandemic will likely impact our lives for the years to come. As the three presented phases show, the pandemic is likely to change its character over time. The transition between phases will possibly take the form of gradual shifts rather than sudden changes. Moreover, infection dynamics – particularly throughout the calibration phase – might look very different from country to country, as they depend on political decisions and societal compliance with restrictive measures.

Despite these remaining uncertainties, however, the three phases help us to clarify the implications of SARS-CoV-2 for urban mobility and public transport. We will explore these implications in the following chapters.

Mobility behavior: Demand, volatility and modal choice

The SARS-CoV-2 pandemic will have substantial effects on mobility behavior in the coming years. Overall, **mobility demand** is likely to rebound after a radical drop during the crisis phase. However, ongoing restrictions and fear of infection are likely to keep overall demand way below previous levels throughout the calibration phase. A substantial recovery of demand becomes more likely towards the conclusion of the pandemic. Even then, notwithstanding, the increasing popularity of home office, e-learning and similar activities might leave overall demand below pre-crisis levels.

We might furthermore see a substantial increase in **demand volatility**, particularly in the calibration phase in which recurring waves of infection might require renewed periods of virus suppression (see box 1, previous chapter).

In terms of **modal choice**, finally, crisis phase observations might suggest a shift from public transport towards individual forms of transportation. At the same time, however, it is by far not clear if this effect will be long-lasting.

Furthermore, we might find that people adapt to the overall volatility throughout the calibration phase and become increasingly flexible in choosing their preferred mode of transportation. While public transport is likely to regain popularity when the epidemic concludes, the growing taste for flexibility might remain one of the longer-term implications of SARS-CoV-2.

Stage 1: Crisis

With the onset of the SARS-CoV-2 crisis, mobility demand has dropped radically across Europe. In Germany, for example, nationwide mobile phone tracking data suggests that the average daily travel distances shrank by 47% between late February and late March 2020.[xii]

Moreover, the data shows a clear shift in transport modes (see figure 3). Cycling has turned out to be the transport mode of the moment with its modal share more than tripling. The modal share of walking almost doubled and that of cars increased by roughly 10%. The modal share of public transport, in contrast, decreased by about one third.

Further data shows that, in major German cities as well as in capitals across Europe, public transport demand shrank by roughly 75 to 95% (see figure 4).[xiii]

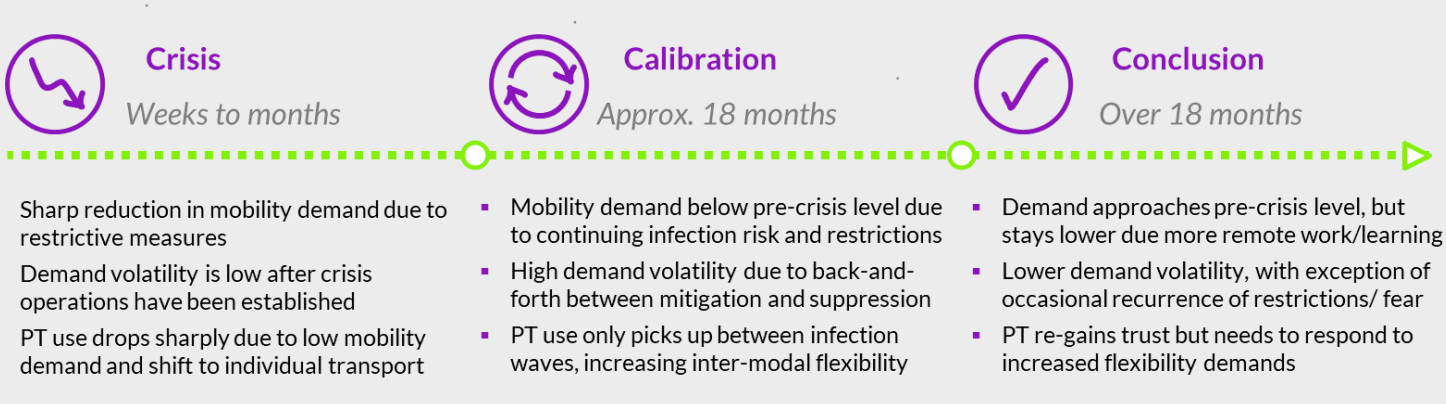

Figure 2: Outlook on the mobility behavior during the SARS-CoV-2 pandemic

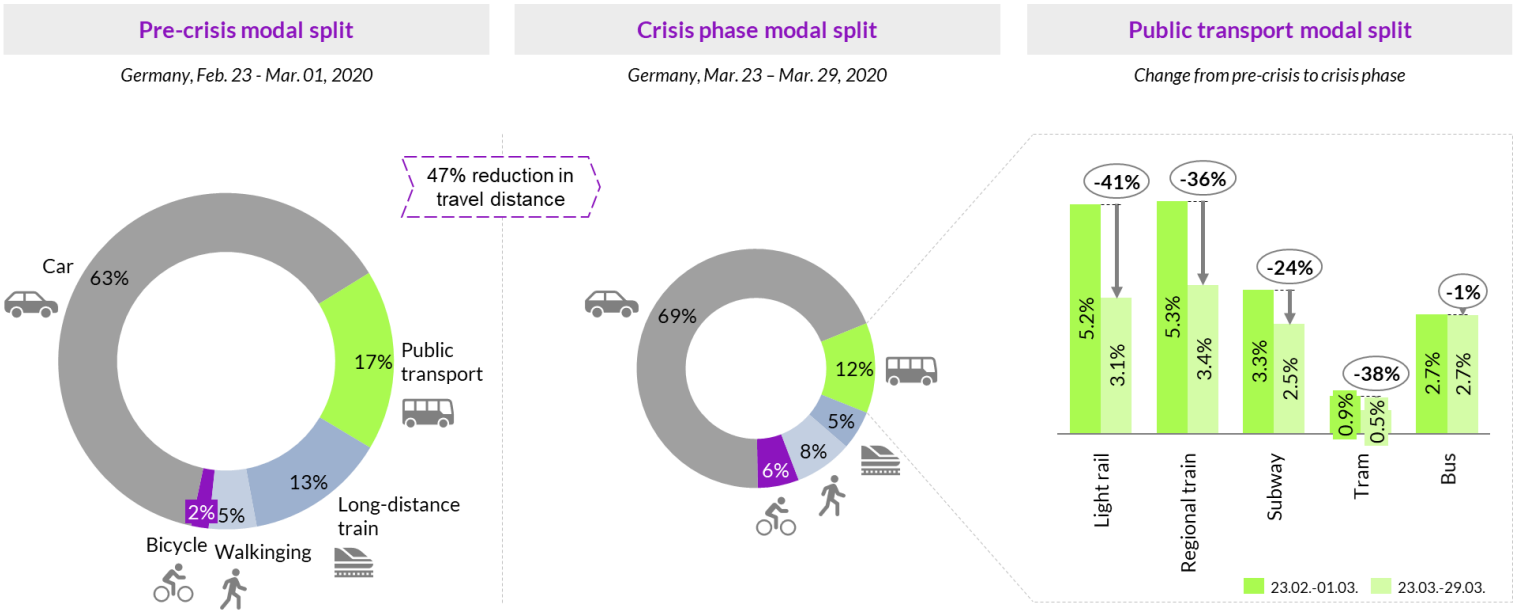

Figure 3: Development of modal split in Germany from End of February to End of March, 2020

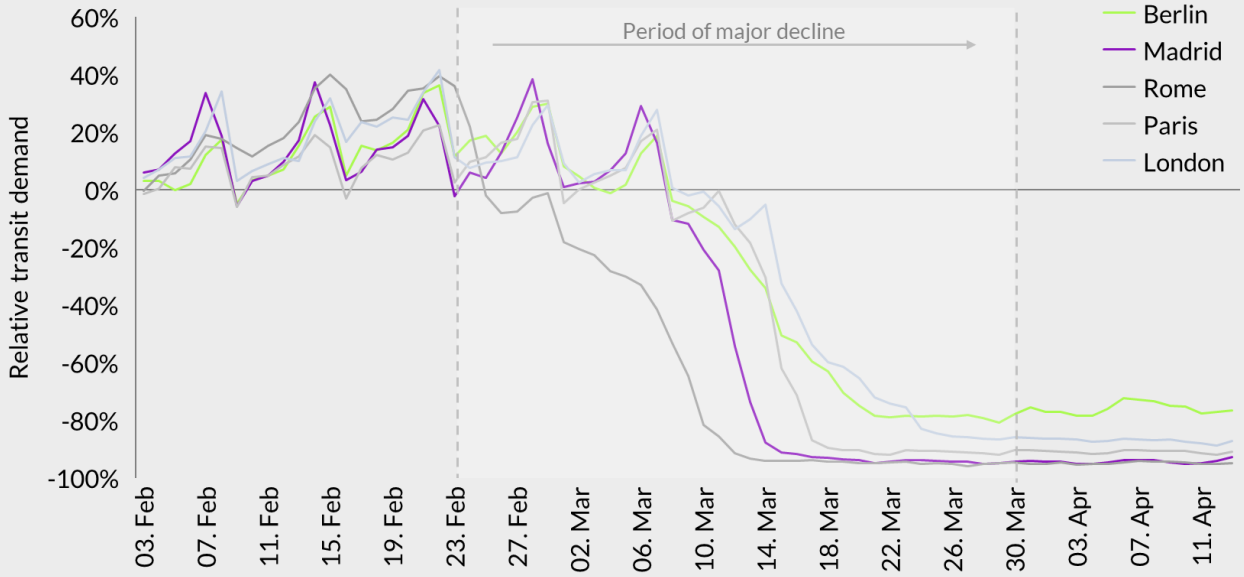

Figure 4: Volume of Apple Maps directions requests per city relative to January 13, 2020

Interestingly, the case of Germany shows that public transport was not affected evenly by the crisis. While all modes experienced a loss of ridership, buses lost riders roughly proportionally to the overall decline in mobility demand. Trains, in contrast, were hit much harder (see figure 3, right side). This phenomenon has also been observed by the Institute for Transportation and Development Policy (ITDP). The organization hypothesizes that users tend to favor buses over the use of metro lines due to perceived difficulties to uphold social distancing in underground spaces.[xiv]

New urban mobility services also reacted drastically to the crisis: Berlin-based ride-sharing service Berlkönig, for example, closed its regular service and focused on transporting medical staff free of charge instead. Similarly, the car sharing service Share Now started to offer special rates for personnel in critical positions (for example, medical and essential services staff). E-scooter sharers, such as Lime, stopped their operations altogether.

Interlude: Scientific insights on pandemics and public transport

When exploring the effect of the pandemic on future mobility demand, studies on previous epidemic and pandemic events help shedding some light on potential developments – particularly when it comes to public transport.

Clear infection risk in public transport, but unclear impact on overall infections

While there remains some controversy, science suggests that public transport usage increases the risk of infection with acute respiratory infections or influenza-like-illnesses.[xv]

It is still somewhat unclear, however, how large the overall effect of infections in public transport is. The early version of a simulation on the spread of SARS-CoV-2 in Berlin, for example, finds that public transport use might be responsible for roughly 10% of overall infections.[xvi]

A simulation study on a hypothetical influenza epidemic in New York City, in contrast, suggests only roughly 4% of infections occurred in the subway system while around 30% occurred in households, roughly 25% in schools and approximately 9% at the workplace.[xvii] A plausible explanation for the lower infection number when compared to the Berlin study might be the New York study's exclusive focus on subways rather than the entire public transport system.

A third, comparable simulation explores a hypothetical influenza pandemic in Beijing. The study suggests that a closure of public transport might reduce the number of hospitalized influenza cases by 20%. Nevertheless, this number is likely to overestimate the effect of public transport for methodological reasons.[xviii]

People tend to overestimate the risk of public transport, but then ignore their own advice

While the actual risk of infection is one thing, perceived risk and behavior is quite another. Indeed, empirical studies on previous epidemics, such as SARS (2002–2003) and A(H7N9) (2013–2017) or pandemics, such as the Swine flu (2009–2010)[xix], show a rather ambiguous picture.

On the one hand, public transport tends to feature high up on the list of places to avoid during times of high risk of infection. When asked about precautionary measures in case of a hypothetical influenza pandemic, Europeans ranked public transport as the riskiest place to be (56% of respondents). Moreover, 79% of respondents reported they would themselves avoid public transport.[xx]

However, this high attention does not necessarily translate into action. In Hong Kong, the link between risk perception and action was surveyed during the combined

occurrence of the second epidemic wave of the avian influenza A(H7N9) virus and the winter peak of seasonal influenza in 2014. When asked about their strategies to reduce risk of infection, roughly 60% of respondents suggested to avoid public places and public transport. However, only 7% did actually do so.[xxi]

Studies from the UK and Spain report similar patterns. UK citizens were interviewed around two weeks after the Swine Flu had reached the UK in April 2009. While around 48% of respondents either strongly agreed or tended to agree that reducing public transport use would be an effective response to the virus, only 2.8% had actually reduced their use of public transport.[xxii] In another study on risk avoidance behavior during the 2009–2010 Swine Flu pandemic in Spain, only circa 3% of respondents reported that they did actually avoid public transport to reduce risk of infection.[xxiii]

Fear-induced public transport avoidance decreases over time

Finally, what does science tell us about rebound effects after a crisis? A study about the impact of the SARS epidemic in Beijing shows that public transport usage collapsed by over 60% at the peak of infections in April 2003. While infection numbers approached zero during the second half of May 2003, it took until early July for ridership to roughly get back to normal.[xxiv]

A SARS study conducted in Taipei suggests that this pattern can be explained by a combination of what the author calls "fresh fear" and "residual fear". The study found patterns similar to those in Beijing. He found out that initial drops in ridership were proportional to the number of newly published SARS cases. Importantly, the drop in passengers was proportional to reported infections and not to the reported deaths. This immediate "fresh fear" effect would then tail off over time. Results show that it took roughly 28 days until all "residual fear" had passed and passenger numbers were back to normal.[xxv] Similar patterns of fresh and residual fear were also observed in Hong Kong during the SARS pandemic.[xxvi]

Taken together, these scientific findings suggest three things: First, given the actual risks of infection, adapting one's modal choice is a viable way of managing risk exposure. Second, stated risk perceptions and intended avoidance strategies do not necessarily translate into action. Published numbers that merely display intended behavior should thus be taken with a grain of salt. And third, those people who do avoid public transport seem to do so because of reported infection numbers rather than reported deaths. After avoiding public transport, it takes them roughly a month to get fully back to normal – in case no further critical developments occur.

With these insights in mind, we now turn to exploring mobility behavior throughout the calibration phase.

Stage 2: Calibration

Mobility demand is likely to increase throughout the calibration phase as restrictive measures are relaxed, crisis fatigue grows, and the immunity within the population slowly increases. Yet, mobility demand might remain well below pre-crisis levels, at least in the earlier stage of the calibration phase. Within the context of a struggling economy, ongoing unemployment would keep on depressing mobilty demand, and so would a persistent degree of digitalization of social life.

Demand volatility is likely to increase substantially during the calibration phase as a result of the back-and-forth between suppression and mitigation measures (see preceeding chapter). Moreover, parts of society could be inclined to overcompensate the periodical loss of

Transportation modes have distinct risk profiles

Schematic evaluation of infection risk perception per transport mode

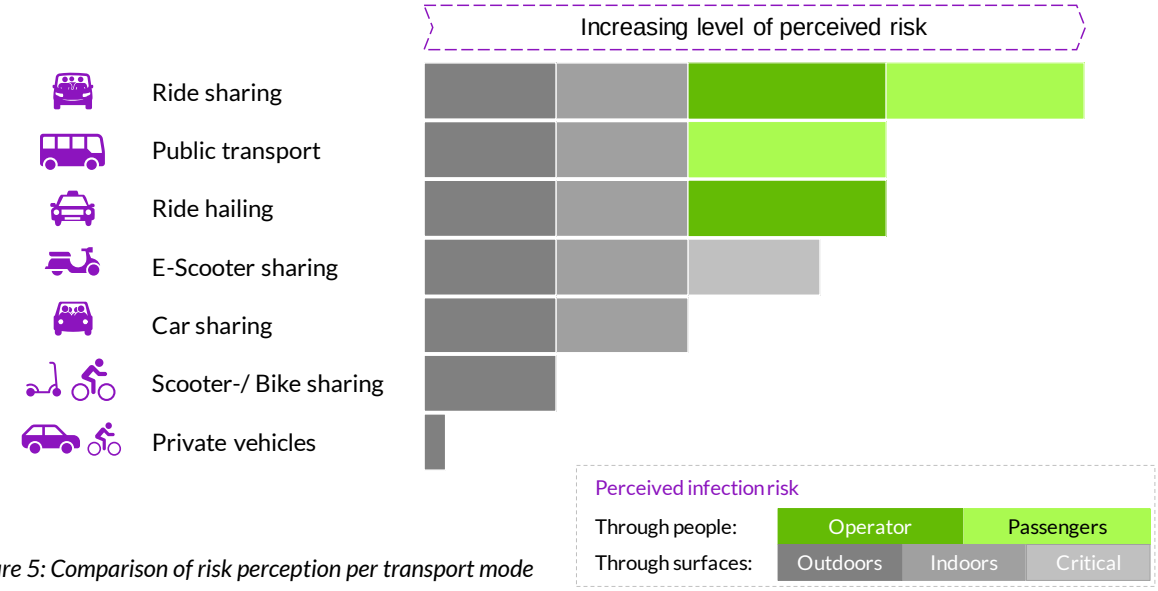

Figure 5: Comparison of risk perception per transport mode

mobility whenever measures are relaxed, further adding to demand volatility.

With respect to modal choice, public transport may continue to suffer. After the current virus outbreak has been brought under control, residual fear is likely to linger on for several weeks. Only as residual fear wears off, higher-risk modes of transportation might become attractive again. An indicative comparison of transport modes shows the relatively high risk associated with public transport use (see figure 5) This suggests that public transport would become an increasingly viable option only when residual fear has mostly vanished.

Under these conditions, public transport would profit from longer time spans between infection waves. Should infection waves come in rapid succession, in contrast, it would be difficult for public transport to regain significant amounts of passengers.

Besides, given the high degree of volatility throughout the calibration phase, people might want to re-evaluate their modal choice on a weekly if not daily basis, depending on the current crisis situation and subjective risk perception. Users could swiftly switch from public transport to private car or bike – and back.

Stage 3: Conclusion

In the conclusion phase, mobility demand is likely to rebound closer to pre-crisis levels. Most restrictive measures will be relaxed, and new behavioral (and maybe legal) norms will reinstate trust. Wearing face masks in public transport, for example, could be one of such trust-building behaviors. Vaccination-induced immunity will furthermore reduce the fear (as well as the actual vulnerability) of broad parts of society.

At the same time, some factors might prevent demand to go fully back to pre-crisis levels. Depending on the economic situation, we might continue to see higher-than-previous unemployment in some countries. Moreover, an overall higher degree of digitalization is likely to be one of the long-term effects of the crisis. Particularly in the area of work and education, this might have a long-term effect on mobility demand. Indeed, in a survey among German employees, roughly

two thirds of the respondents stated that they would like to work from home more frequently in the future.[xxvii] Preliminary results of a study surveying employees in the UK show similar results. 29% of respondents across all age groups would want to re-balance time between home office and physical offices in the long term. 17% of respondents would even want to work from home entirely. The authors suggest that this might result in a 20-25% decrease in overall commutes.[xxviii]

Demand volatility is likely to be driven by two counteracting effects – one increasing volatility, the other one reducing it. First, an occasional recurrence of local surges in SARS-CoV-2 infections might provoke the reinstallation of restrictions for those parts of society not yet immune to the virus. Secondly, current experiences with more flexible work arrangements might not only affect the overall number of commuters. They might also serve as a catalyst for more flexible working hours in the longer run. Such flexibility might reduce peak demand and help to distribute passengers more evenly across the day, for example, when people decide to work from home in the morning, commute to work during lunch break and spend the rest of the day in the office for meetings.

Finally, the overall modal share of public transport is likely to recover throughout the conclusion phase. Public transport will continue to profit from new behavioral and legal norms, and immunity will make the use of public transport less risky. While some suggest that the private car might be the big winner of the SARS-CoV-2 pandemic, available data seems to contradict this assumption. A recent survey among German citizens suggests that only cycling and walking might significantly gain popularity in the long term, whereas private car use may stay about the same (see figure 6). The data also shows that changes in the use of public transport might be the most pronounced. Only 52% of respondents stated their use of public transport would stay the same. However, the coming change must not necessarily be a negative one. While 19% of respondents suggested they would use public transport less frequently in the future, roughly the same amount of people (17%) might use public transport even more than before the crisis.[xxix]

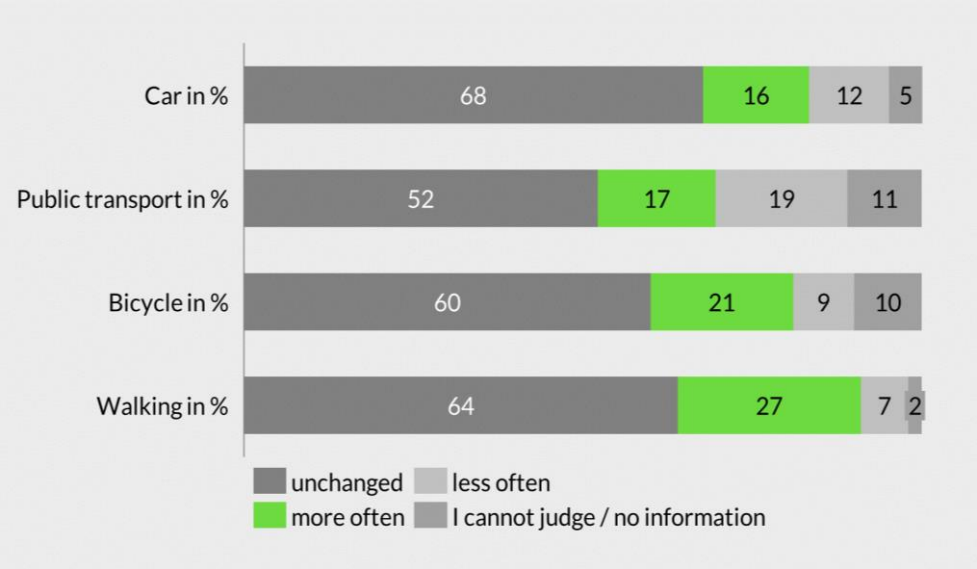

Figure 6: Change of transport mode usage after the SARS-CoV-2 crisis.[xxix]

Additionally, it is likely that some behavioral changes might stick. Public transport companies and authorities might be confronted with increased expectations regarding flexibility (e.g. in pricing schemes) and multi-modal integration after passengers have gotten used to these features throughout the calibration phase.

Overall, urban mobility will change a lot across the different phases of the pandemic. It is important to note that the developments explored here assume no explicit strategic measures taken by public transport authorities and companies. In the next chapter, we explore what the latter can do to improve the position of public transport throughout the pandemic.

Public transport strategy: The importance of core initiatives

Public transport authorities and companies are doing everything they can to tackle the immediate operational challenges that the SARS-CoV-2 crisis is confronting them with. For example, they increased the cleaning and disinfection of vehicles and stations, took further actions to protect staff and passengers, and implemented new occupancy limitations to enable social distancing.

These measures are essential immediate reactions to the SARS-CoV-2 pandemic. As we move from the crisis phase to the calibration phase of the pandemic, however, longer-term strategic considerations come to the fore.

In this chapter, we explore these longer-term considerations. While some people question the long-term viability of public transport, we find that it remains the essential backbone of urban mobility.

It is important, moreover, to continue pushing for a transformation of the sector. Major strategic initiatives should not be sidelined or halted. On the contrary, we find that these initiatives – namely expanding the public transport offer, multi-modal integration, simple and flexible pricing, pushing digitalization and building agile organizations – have a crucial role to play in navigating the pandemic in the years to come.

We build the following discussion based on the insights generated in the preceding two chapters. We furthermore conducted circa 20 interviews with public transport operators, authorities and experts as well as with new mobility players from across Europe as well as from East Asia, the Middle East and Latin America.

As suggested previously, this paper focuses on a scenario that zooms in on anticipated challenges. Nevertheless, we also briefly discussed a potential best-case scenario.

> ***"Nobody was prepared for this"*** *- Public Transport Operation Manager in Southern Europe*

Such scenario remains a possibility. It is thus important to stress that the strategic initiatives explored in this chapter are "future-proof", meaning that they will bring substantial benefits both in a best-case scenario as well as in a scenario focused on challenges.

In some cases, their added value might be different across scenarios. Take the case of public transport offer expansion, for instance: In the best-case scenario, this strategy remains essential to promote public transport and thereby makes urban mobility more accessible and sustainable. In the scenario that focuses on the challenges of the pandemic, it is just as important. However, particularly during the next two years, its major value added will not necessarily lie in winning new customers, but in two other aspects: Letting previous customers back into the system while adhering to social distancing, and providing direct and city-specific economic stimuli through associated infrastructure projects.

There is no alternative to public transport as the backbone of urban mobility

Urban mobility has faced fundamental challenges way before the SARS-CoV-2 pandemic, such as overwhelming congestion and climate and air quality concerns. Public transport has been a key factor in tackling these challenges. But given the grave impact of the SARS -CoV-2 pandemic, should we reconsider the strategic importance of public transport in urban mobility?

To put it simply: No. There is no alternative to public transport in urban mobility. Indeed, many people have announced the great comeback of the private car.

Considering the varying risk profiles across transport modes (see figure 5, previous chapter), such suggestion might seem plausible. However, the survey data presented in the previous chapter does not show clear evidence that people are going to avoid public transport in the longer run. It is thus likely that the demand for public transport services will persist.

"Right now, we are convincing people to stop using public transport, and afterwards we will need to convince them to come back" *- Public Transport Organization Coordinator in Eastern Europe*

Moreover, attractive public transport is also essential when considering the continuing or even growing pressure on urban public space. Figure 7 presents a thought experiment showing the effect on public space that a radical reduction of public transport would have. Building on the crisis-phase modal shift previously presented, the figure assumes a hypothetical halving of public transport's modal share in the post-pandemic future. It furthermore assumes that roughly half of this share shifts to private cars. The result quickly shows how such a growth in private car ownership would overburden public urban space.

Expanding the public transport offer remains fundamental

But does it make sense to expand the public transport offer? Here, the answer is yes. Expanding offer remains an essential strategy for the future of urban mobility. In pre-pandemic times, this strategy was important for the aforementioned reasons: fighting congestion as well as air pollution and climate change. SARS-CoV-2 does not change the importance of this agenda.

However, the SARS-CoV-2 pandemic adds further reasons for expanding public transport. In the short term, these reasons primarily concern the bus system, since it is likely that the customers' preference for buses over trains and trams will persist until residual fear tails off substantially. Nonetheless, strategic considerations with respect to rail-based modes of transportation should not be disregarded, since they remain essential for urban mobility in the long run.

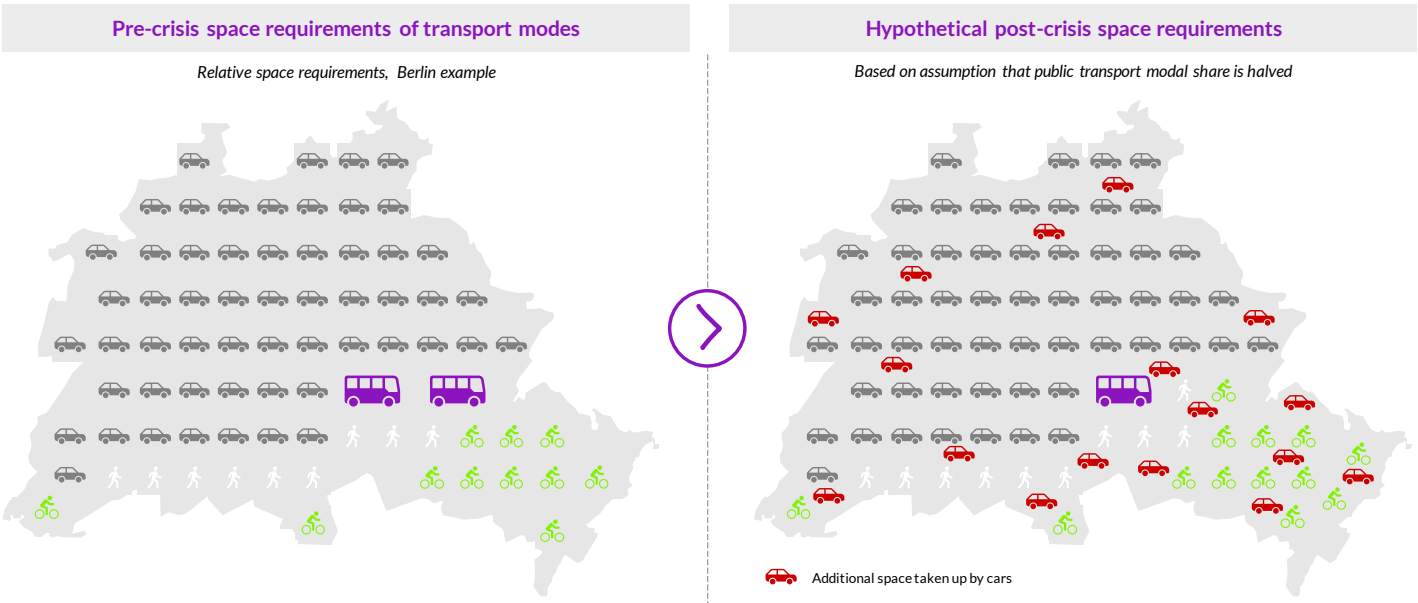

Figure 7: Representation of relative space used by vehicles and people. Infrastructure is not considered. Variation between maps is based on hypothetical change in modal split: Pre-crisis based on 2018 Berlin modal split, hypothetical post-crisis assuming that modal share of public transport decreases by 50%, and the modal shares of cars, bikes and walking go up by 7.5%, 4% and 2% respectively. Shared assumptions: Constant overall mobility demand, based on assumption that mobility demand p.c. might approach pre-crisis levels in the conclusion phase and cities are likely to grow further. Constant occupancy of 1.3 individuals per car and 40 individuals per bus. Constant space requirements of 1 sqm per pedestrian, 2 sqm per biker, 10 sqm per car and 30 sqm per bus.

"Keeping social distancing with a growing number of passengers is a real challenge in public transport" *- Public Transport Planning Lead in Latin America*

The following are key aspects of offer expansion strategies in times of the SARS-CoV-2 pandemic:

- Some degree of social distancing is likely to persist, at least until the second half of 2021. This reduces the number of users that public transport can bring on board. Thus, more capacity will be needed to accommodate those passengers who will come back as soon as suppressive measures are lifted.
- The pandemic provides a critical window of opportunity for offer expansion. The current situation might make things possible (e.g. pop-up bus and bike lanes) that would otherwise not have seemed viable. The pandemic thus provides a chance to implement measures and run trials that could become permanent in the longer run.
- Thinking some months ahead, furthermore, expanding public transport can function as direct and city-specific economic stimuli. This is particularly true for infrastructure projects, such as new, dedicated bus lanes, new bus stops or whole new metro lines. Importantly, infrastructure design will need to take into account the longer-term potential for recurrent social distancing measures.
- Finally, particularly train and metro projects are very long-term. While they start stimulating local economies from the beginning of construction, their effect on urban mobility needs time. Even if the pandemic goes on for several years, it is likely to be defeated for the most part by the time those projects that are now in planning would start operating.

Multi-modal integration creates flexibility and responds to customer preferences

The integration of new mobility services into a multi-modal mobility offer is another field of essential strategic action. Over recent years, new mobility services have expanded radically. Shared cars, bikes, and different kinds of scooters are now widely available across cities, and so are ride hailing and sharing services.

If and how these services contribute to a sustainable and effective urban mobility ecosystem is intensely debated. Ride hailing providers such as Uber and Lyft, for example, have been proven to create more congestion.[xxx] E-Scooters have also been blamed for being unsafe, taking up public space and lacking economic and environmental sustainability.

Nevertheless, public transport is beginning to explore areas of cooperation with some new mobility players such as on-demand ride sharing services. These services follow a business model closer to that of mass public transport, using larger vehicles to pool multiple passengers.

"We strongly believe in Mobility-as-a-Service and flexible services, but mass transit needs to be the backbone" *- Public Transport Organization Vice President in Northern Europe*

Examples for cooperation include Berlin's public transport provider BVG, who teamed up with ViaVan to create the ride sharing service Berlkönig. In another example, the municipality of Sant Cugat, in the Barcelona province, worked with on-demand mobility provider Shotl to connect neighborhoods to train stations. In the context of the SARS-CoV-2 crisis, MOIA – another ride sharing provider – began cooperating with the Hamburg Transport Association (HHV) to take over certain night services.

In some cases, public transport companies have gone even further by integrating several mobility services into one combined

offer. Within its Jelbi App, BVG offers public transport, its Berlkönig offer, as well as shared cars, bikes and different kinds of scooters that are operated by cooperation partners. Jelbi also provides initial evidence of the advantage of such multi-modal platforms in the context of the SARS-CoV-2 pandemic. Between January and April 2020, the app experienced a 90% decline in public transport bookings. At the same time, however, the booking of shared services increased by 6% with a focus on shared bikes. These figures point towards the essential value added by multi-modal integration in navigating the SARS-CoV-2 pandemic:

"Our multi-modal offer helps us to rebuild trust in public transport and to flexibly react to crisis developments" – *Public Multi-Modal Platform Chief in Norther Europe*

- Multi-modal integration can help public transport to generate customer loyalty by keeping them within their own public-transport-centric ecosystem/app even in volatile times. Within this eco-system users can move from the bus to shared cars or bikes when infection numbers rise. More importantly even, they can move back to bus and train just as quickly when infection risk decreases.
- Moreover, multi-modal solutions can help to reduce the abovementioned demand pressure on bus systems throughout the calibration phase. When bus occupancy reaches the limits induced by social distancing, for example, passengers could be asked to move from buses to shared bikes or scooters. Such strategy would ensure continuous mobility while reducing infection risks.
- Moreover, the SARS-CoV-2 pandemic opens a crucial window of opportunity for negotiating multi-modal integration. Many new mobility players are suffering from the pandemic too. This might increase their willingness to discuss a more thorough integration into city-wide collaboration schemes that do not exclusively focus on clustering their services and assets in city centers.
- In the long term, multi-modal offers might become even more important. As discussed in the previous chapter, the pandemic is likely to have a sustained effect on customer preferences. Users' thirst for flexibility is likely to last beyond the crisis. In the longer run, therefore, passengers might simply come to expect a much higher degree of multi-modal integration from their public transport providers.

Simple and flexible pricing creates customer trust

Pricing is an essential and contested component of public transport services. The 365-EUR ticket introduced in Vienna has led to much debate. Luxemburg even made public transport entirely free of charge. While attractive for passengers, these initiatives have also generated criticism: They would be expensive for authorities and companies, might not make people leave their cars at home, and would not be effective without a parallel expansion of public transport offer and quality.[xxxi]

Other cities, such as London, have chosen another way by installing pay-as-you-go ticketing systems. The London system includes automatic payment caps that kick in when certain daily or weekly limits are reached. Without having to engage in a debate about free public transport, such flexible pricing systems can substantially help to navigate the SARS-CoV-2 pandemic.

Indeed, in Hong Kong, the local Octopus Card system has been leveraged to take quick action to counter the effect of the SARS-CoV-2 pandemic: Operators extended the validity of digital public transport passes within the system, and the government has increased transportation subsidies by reimbursing one third of fare payments as soon as passengers spend over 200 Hong Kong Dollars a month on the system. Aggregated statistical data generated within the Octopus system is furthermore used to cooperate with the Faculty of Medicine, University of Hong Kong, in researching to contain the spread of the pandemic.

"One centralized payment platform that can process transactions immediately across different modes is essential to acknowledge people's value of time" *– Mobility Smart Card Payment Expert in East Asia*

More broadly speaking, simple and flexible pricing schemes can help in navigating the SARS-CoV-2 pandemic in several ways:

- As the Hong Kong example shows, digital pricing models can be adopted quickly to reward passengers for their loyalty, be it in terms of prolonging the validity of tickets or giving them discounts on future purchases.
- Simple and flexible pricing schemes can help generating customer trust. Given the risk of new infection waves throughout the calibration phase, monthly or even annual public transport tickets become unattractive. Riding on individual tickets, in contrast, is more expensive. Simple pricing schemes and payment caps can re-assure passengers that they will always use the most favorable fare.
- Intelligent and dynamic pricing could furthermore be used to influence travel flows and thus regulate the crowdedness of vehicles and stations in times of higher risks of infection.
- In the longer run, such flexible pricing schemes can be merged with the multi-modal integration described above, allowing for innovative mobility-as-a-service solutions that might generate new business opportunities for the more progressive public transport companies.

Digitalization holds great potential to support the transformation of public transport

Digitalization comprises a variety of phenomena that range from the growing general importance of doing things online, through the development of new, often app-based business models, to the rise of cloud computing, big data analytics, and artificial intelligence. These themes have been on the top of the economic and political agenda for years.

"Embracing innovation, including digitalization, will be key to the survival of public transport" *- Public Transport Strategic Planner in Southern Europe*

Digitalization also holds great potential for public transport, both with respect to user interaction as well as to the improvement of internal processes and operations. However, the sector is embracing the full potential of digitalization only slowly.

As outlined in the previous chapters, the pandemic is already pushing digitalization in various areas, such as working and learning from home. For public transport authorities and companies, however, digitalization has a much larger potential than simply allowing for work from home:

- Digitalization is a fundamental building block of multi-modal integration and simple and flexible pricing schemes, as highlighted above. Flexible pricing, for instance, builds on ridership analytics,

automatically assigning and capping fares, and undertaking automatic payment processes. All these demand a high degree of digitalization.

- Online ticketing, more generally, significantly reduces infection risks. It helps users to avoid interaction with physical surfaces, tickets and cash when purchasing or validating tickets. In buses, this effect is particularly high when compared to a situation where tickets are purchased directly from the driver.
- Direct and real-time communication is another key advantage of digital channels. Mobile push notifications, for example, efficiently update passengers on changes in risk levels and public transport service.
- Data analytics and AI tools, furthermore, can help generating systematic and near-real-time information about occupancy, travel flows and system bottlenecks. On one hand, such data can inform passengers about the crowdedness of different routing options, helping them to make informed travel decisions. On the other hand, it can help operators to adapt their services and reduce the occurrence of bottlenecks.
- Finally, internal operations and workflows also profit from process digitalization, big data analytics and AI. These help to analyze, visualize and handle increased volatility in, for example, human resources, operations and maintenance as well as in procurement. In HR, for example, dynamic workforce planning can help avoiding short-term driver shortages. It can also assist in tracing infection dynamics among employees and thus help to contain follow-on infections.

Agile organizations are faster and more effective in crisis response and transformation

The term "agile" refers to a specific working style that originates in software development but has gained traction in a much wider range of activities and organizations by now.[xxxii] It highlights self-directed work in small, cross-functional teams. Such work is structured in consecutive iterative cycles (sprints) and prioritizes the fast testing of prototypes over long-term, waterfall-style project management.

Here, we use the term "agile" in a somewhat broader sense to refer to an organization that is capable of making fast and well-informed decisions, that can quickly adapt to the apparent volatility throughout the pandemic, and that can implement initiatives in a target-oriented and fast way.

Building such organization might not have been a major priority for most public transport companies and authorities until now. However, as the preceding chapters show, the public transport sector will confront an unprecedented level of volatility. It is likely that it will have to handle great fluctuations in passenger numbers, changing safety and hygiene regulations, a higher volatility in the workforce, and potential bankruptcies or impediments of 3rd party service providers and suppliers.

In such a situation, it is essential to be agile in the sense outlined above. Moreover, an agile organization is much more likely to effectively and quickly pilot the initiatives discussed in this chapter so far:

- A crisis reaction team can help to constantly monitor the pandemic and to design, prioritize and kick off initiatives to respond to the changes and challenges identified. Four things help to ensure the effectiveness of such team: A direct report to senior management, clearly defined interfaces with

strategy, operations, and other core departments, access to data analytics, and capacities for scenario-planning as a tool to anticipate potential future developments and increase preparedness.

- Agile teams, following the more specific working methods outlined above, can help greatly in implementing the strategic initiatives discussed so far. They can also help implementing short-term operational adjustments made necessary by the pandemic - for example the installation of pop-up bike or bus lanes. Building on agile teams means to focus on concrete and applied pilot projects, bring these into action quickly, and learn and adapt on the way.
- An overarching Project Management Office (PMO), closely related to the crisis reaction team, can help oversee ongoing projects, track progress, and intervene in case expectations are not met. It is essential that the PMO takes a proactive role in engaging with project teams, challenging them on the quality of their outputs and helping them to create the conditions under which they can effectively reach their goals.
- Furthermore, systematically analyzing and redesigning core processes, such as the planning of new bus lines, can free up essential resources and increase the speed of an organization substantially. Such redesign should leverage new digital tools and have a radical focus on the final outcome of a process.
- Finally, for organizations that have long operated in a rather steady-state environment, it is key to accompany the above initiatives with active change management. Willing employees might embrace new ways of working. However, more reluctant employees also need to be brought on board, since they will need to apply new processes and interact with more agile teams. To win these employees over, leadership commitment and a communication of early successes and improvements are crucial. Moreover, employees need to be convinced of the value of new processes, and they need to be trained to apply them.

[i] Version 1.04 contains additional information on SARS-CoV-2 (see ii) and "fresh" and "residual" fear in the Mobility Chapter and some corrections of minor linguistic, spelling and visual errors.

[ii] Severe acute respiratory syndrome coronavirus 2. A new type of coronaviruses, causing the disease COVID-19.

[iii] For initial tests in this regard see:
Alex W H Chin et al., "Stability of SARS-CoV-2 in Different Environmental Conditions," *The Lancet Microbe*, April 2020, 1–1.

[iv] Matthias Horx, "Die Welt Nach Corona: Wie Wir Uns Wundern Werden, Wenn Die Krise Vorbei Ist," *Kress News*, March 19, 2020.

[v] N. Ferguson et al., "Report 9: Impact of Non-Pharmaceutical Interventions (NPIs) to Reduce COVID19 Mortality and Healthcare Demand," Report, March 16, 2020.

[vi] Patrick GT Walker et al., "Report 12: The Global Impact of COVID-19 and Strategies for Mitigation and Suppression" (Imperial College London, March 26, 2020).

[vii] Philipp Carlsson-Szlezak, Martin Reeves, and Paul Swartz, "Understanding the Economic Shock of Coronavirus," *Harvard Business Review*, March 27, 2020.

[viii] The number of projects reflects WHO official figures as per
"DRAFT Landscape of COVID-19 Candidate Vaccines" (WHO, April 11, 2020).

[ix] "Meeting of Top Scientists Underway to Slow Coronavirus Spread," UN News, February 11, 2020.

[x] Robert Kuznia, "The Timetable for a Coronavirus Vaccine Is 18 Months. Experts Say That's Risky," CNN, April 1, 2020.

[xi] Shawn Radcliffe, "How Long Will It Take to Develop a Vaccine for Coronavirus?," Healthline, January 30, 2020.

[xii] Data by courtesy of MOTIONTAG. Numbers compare last week of February to last week of March 2020. MOTIONTAG uses smartphone sensor- and location-data, complemented with 3rd party data, to generate insights on movement patterns and transportation modes.

[xiii] Measured through the number of direction requests in Apple Maps. Data available at https://www.apple.com/covid19/mobility

[xiv] "Post-Pandemic, Chinese Cities Gradually Reopen Transport Networks," Institute for Transportation and Development Policy, March 26, 2020.

[xv] Some studies find no indication of or only ambiguous evidence for such increased risk:
Joy Troko et al., "Is Public Transport a Risk Factor for Acute Respiratory Infection?," *BMC Infectious Diseases* 11, no. 1 (December 2011): 16.

Alma J Adler et al., "Incidence and Risk Factors for Influenza-like-Illness in the UK: Online Surveillance Using Flusurvey," *BMC Infectious Diseases* 14, no. 1 (December 2014): 232.

Caroline Guerrisi et al., "Participatory Syndromic Surveillance of Influenza in Europe," *The Journal of Infectious Diseases* 214, no. suppl_4 (December 1, 2016): S386–92.

Annie Browne et al., "The Roles of Transportation and Transportation Hubs in the Propagation of Influenza and Coronaviruses: A Systematic Review," *Journal of Travel Medicine* 23, no. 1 (January 2016).

Notwithstanding, most recent studies suggest that using public transport increases the risk of infection: Caroline Guerrisi et al., "Factors Associated with Influenza-like-Illness: A Crowdsourced Cohort Study from 2012/13 to 2017/18," *BMC Public Health* 19, no. 1 (December 2019): 879.

Lara Goscé and Anders Johansson, "Analysing the Link between Public Transport Use and Airborne Transmission: Mobility and Contagion in the London Underground," *Environmental Health* 17, no. 1 (December 2018): 84.

Tapani Hovi et al., "Development of a Prognostic Model Based on Demographic, Environmental and Lifestyle Information for Predicting Incidences of Symptomatic Respiratory or Gastrointestinal Infection in Adult Office Workers," *Trials* 17, no. 1 (December 2016): 545.

[xvi] Updated numbers based on interview with the authors on April 16, 2020. Original study: Sebastian Alexander Müller et al., "Mobility Traces and Spreading of COVID-19," March 20, 2020.

[xvii] Philip Cooley et al., "The Role of Subway Travel in an Influenza Epidemic: A New York City Simulation," *Journal of Urban Health* 88, no. 5 (October 2011): 982–95.

[xviii] The agent-based simulation assumes that those users unable to substitute their bus or train ride (e.g. by walking or taking the car) would stay home. Consequentially, they cannot get infected at their originally planned destination – for instance, their workplaces. The 20% case reduction includes this effect of less infections at work etc. It can thus not be attributed exclusively to infections in public transport itself.
Mingxin Zhang, Rongqing Meng, and Alexander Verbraeck, "Including Public Transportation into a Large-Scale Agent-Based Model for Epidemic Prediction and Control," in *Proceedings of the Conference on Summer Computer Simulation*, SummerSim '15 (Chicago, Illinois: Society for Computer Simulation International, 2015), 1–8.

[xix] The three epidemics/pandemics refer to the virus outbreaks caused by SARS-CoV-1, the Avian Influence A(H7N9) virus and the influenza A (H1N1)pdm09 virus, respectively.

[xx] Overall, five European regions participated in the survey: Spain, Poland, Denmark, Great Britain and the Netherlands.
M. Zia Sadique et al., "Precautionary Behavior in Response to Perceived Threat of Pandemic Influenza," *Emerging Infectious Diseases* 13, no. 9 (September 2007): 1307–13.

[xxi] Emily YY Chan et al., "Knowledge, Attitudes, and Practices of Hong Kong Population towards Human A/H7N9 Influenza Pandemic Preparedness, China, 2014," *BMC Public Health* 15, no. 1 (December 2015): 943.

[xxii] G J. Rubin et al., "Public Perceptions, Anxiety, and Behaviour Change in Relation to the Swine Flu Outbreak: Cross Sectional Telephone Survey," *BMJ* 339, no. jul02 3 (July 2, 2009): b2651–b2651. 1

[xxiii] Fernando Agüero et al., "Adoption of Preventive Measures during and after the 2009 Influenza A (H1N1) Virus Pandemic Peak in Spain," *Preventive Medicine* 53, no. 3 (September 2011): 203–6.

[xxiv] Philippe Beutels et al., "The Economic Impact of SARS in Beijing, China," *Tropical Medicine & International Health* 14 (November 2009): 85–91.

[xxv] Kuo-Ying Wang, "How Change of Public Transportation Usage Reveals Fear of the SARS Virus in a City," ed. Volker Thiel, *PLoS ONE* 9, no. 3 (March 19, 2014): e89405.

[xxvi] Gabriel M. Leung et al., "Longitudinal Assessment of Community Psychobehavioral Responses During and After the 2003 Outbreak of Severe Acute Respiratory Syndrome in Hong Kong," *Clinical Infectious Diseases* 40, no. 12 (June 15, 2005): 1713–20.

[xxvii]Verena Urmann, "Digitalisierung durch Corona?," *bidt* (blog), April 15, 2020.

[xxviii] Andrew Allum, "How Will Commuters React to the Home Working Experience? Survey Data Suggests Almost 50% Will Travel Less in the Future," LinkedIn, April 8, 2020.

[xxix]Survey among 2145 German citizens older than 18 years. Results representatively weighed according to age and gender.
Helmuth Meyer, "Wie Corona Unsere Mobilität Verändert," ADAC, April 8, 2020.

[xxx]An analysis of their impact on traffic in San Francisco suggests that they have been responsible for roughly half of the increasing congestion between 2010 and 2016.
Joe Castiglione et al., "TNCs & Congestion Data Report" (San Francisco County Transportation Authority, October 2018).

[xxxi] Dieter Fockenbrock, "Warum Kommunale Unternehmen Gegen Das 365-Euro-Ticket Sind," Handelsblatt, January 28, 2020.

[xxxii] Darrell K. Rigby, Jeff Sutherland, and Hirotaka Takeuchi, "Embracing Agile," *Harvard Business Review*, May 1, 2016.