Acknowledgments

Authors:

Albert Gragera, University of Barcelona & Danish Technical University

Daniel Albalate, University of Barcelona

Germá Bel, University of Barcelona

Gretel Schaj, BABLE GmbH

Hector Cañas, BABLE GmbH

Inés Aquilué, CARNET - Centro de Innovación y Tecnología de la UPC

Jana Helder, BABLE GmbH

Lara Espindola, Universitat Politècnica de Catalunya

Miquel Martí, Universitat Politècnica de Catalunya

Miguel Mósca, BABLE GmbH

Mikael Edelstam, Miljöstrategi AB

Pierre Filohn, BABLE GmbH

Raúl Urbano, Centro Tecnológico de Automoción de Galicia

Contributors:

Alessandro Drago, City of Rome

Dr. Anna Clark, EIT Urban Mobility

Camilla Wikström, City of Stockholm

Daniel Serra, EIT Urban Mobility

Delia Mitcan, EIT Urban Mobility

Ivo Cré, Polis

Jaanus Tamm, City of Tartu

Jaime Valdés, City of Lindau

Jordi Plumed, Santa Coloma de Gramanet

Peter Kisch, City of Lund

Peter Vest, EIT Urban Mobility

Sandra Lima, European Passenger Federation

Surveyed Cities:

Antwerp (Belgium)
Barcelona (Spain)
Belgrade (Serbia)
Funchal (Portugal)
Graz (Austria)
Lund (Sweden)
Lviv (Ukraine)
Odense (Denmark)
Rome (Italy)
Rubí (Spain)
Santa Coloma de Gramanet (Spain)
Sint-Niklaas (Belgium)
Stockholm (Sweden)
Tampere (Finland)
Tartu (Estonia)
Würzburg (Germany)
# Table of Contents

Acknowledgments .......................................................................................................................... 1
List of Figures ................................................................................................................................. 4
Introduction .................................................................................................................................. 6
1 Chapter: Challenges, requirements and strategies of sustainable urban mobility systems ........... 7
  1.1 Urban mobility: the pre-pandemic context ................................................................................. 7
  1.2 Challenges & Requirements of urban mobility systems ......................................................... 8
    1.2.1 The urgent need to face Climate Change and improve Urban Health ............................... 8
    1.2.2 A societal choice: reclaiming road space for civic uses while ensuring a competitive economy 9
    1.2.3 Governance & Technological Innovations as enhancing opportunities ....................... 10
  1.3 Strategies for the transition towards sustainable urban mobility ........................................... 14
    1.3.1 Proximity Urban Planning ............................................................................................. 14
    1.3.2 Seamless Intermodality .............................................................................................. 19
    1.3.3 Public Space Redesign ................................................................................................. 22
  1.4 To start a discussion: two hypotheses ..................................................................................... 27
2 Chapter: Effects of COVID-19 on Urban Mobility Systems ........................................................... 28
  2.1 Impacts of COVID-19 in Urban Mobility Systems ................................................................... 28
    2.1.1 Reduced demand for mobility ........................................................................................ 29
    2.1.2 Increased demand for last mile logistics due to e-commerce ........................................ 31
    2.1.3 User Behaviour ........................................................................................................... 32
    2.1.4 Transition to private cars .............................................................................................. 33
    2.1.5 Reduced use of public transport .................................................................................. 34
    2.1.6 Decreased use of shared mobility ................................................................................ 35
    2.1.7 Reduced Investments in strategic research and development ....................................... 36
  2.2 Public Sector Measures ........................................................................................................... 38
    2.2.1 Increasing Public and Shared Transport Safety and Trust .............................................. 38
    2.2.2 Rethinking streets: Pedestrianisation .......................................................................... 41
    2.2.3 Making cycling more attractive through infrastructure developments ........................ 42
    2.2.4 Addressing air pollution from mobility sources ............................................................ 44
    2.2.5 Freight and urban logistics ........................................................................................... 46
    2.2.6 Using data to accelerate and improve decision-making ................................................ 47
Chapter: Innovation in cities as enabler of the transition

4.1 Introduction ........................................................................................................... 71
4.2 Mobility as a wicked problem ............................................................................... 72
4.3 Innovation, collaboration and governance models ............................................... 72
4.4 Action space and relational space ........................................................................ 74
4.5 The short-term impact of COVID-19 on innovation collaboration ...................... 75
4.6 Organisation of innovation work in cities ............................................................ 75
4.7 Who should be involved? ....................................................................................... 77
4.8 A snapshot of innovative measures and mobility strategies due to COVID-19 crisis ........................................................................................................... 78
4.9 The need to align different levels in the system .................................................... 80
4.10 Results from the survey ....................................................................................... 81
4.11 Other emerging strategies from an international outlook .................................... 85
4.12 Data as driver of transformation .......................................................................... 85
4.13 Data-driven innovation ......................................................................................... 88
4.14 How cities finance innovative actions on mobility .............................................. 88
4.15 Discussion ............................................................................................................. 91

Chapter: Economic impact of COVID-19 – Looking Forward ................................... 93

5.1 The forces shaping urban form and mobility patterns ......................................... 94
5.1.1 Available evidence: A pre-pandemic overview ................................................. 94
5.1.2 How is the pandemic affecting the equilibrium between these forces? .............. 97
5.2 Impact assessment of COVID-19 in the mobility marketplace ............................. 103
5.2.1 Implications for public transit ........................................................................... 103
5.2.2 Modal shift towards individual mobility ............................................................ 105
5.2.3 Supply chain (Urban freight) ............................................................................ 111
5.2.4 Parking ............................................................................................................. 112
Impact of mobility-related measures implemented by cities .......................................................... 113

5.3.1 Safer public transit .......................................................................................................................... 113

5.3.2 Reclaiming public space and sustainable mobility promotion .................................................. 115

5.3.3 Traffic management and car access restrictions .............................................................................. 118

5.4 Discussion ........................................................................................................................................ 120

Conclusion ................................................................................................................................................ 123

Key Recommendations: .......................................................................................................................... 124

Bibliography ............................................................................................................................................. 126
List of Figures

Figure 1 - Challenges & Requirements for Urban Mobility systems ..............................................................13
Figure 2: Change in average mobility of people in transit by continent (Corpus-Mendoza, Ruiz-Segoviano, Romero-Contreras, Yanes-Dávila, & Hernández-Granados, 2020) ..........................................................................................................................29
Figure 3: Time-series of daily percentage of reduction (CVD-REF) calculated for each country (urban and rural areas) and three pollutants: PM2.5, NOx and O3. Results are presented for the whole month of March 2020 and for Great Britain, Netherlands, Germany, Spain, France and Italy (Menut, et al., 2020) .30
Figure 4: E-Commerce purchase frequency change due to the COVID-19 outbreak (Pantelimon, Georgescu, & Posedaru, 2020) .........................................................................................................................................................31
Figure 5: The effect of COVID-19 on the global online traffic by industry in April 2020 (Pantelimon, Georgescu, & Posedaru, 2020) .........................................................................................................................................................32
Figure 6: Key reasons to choose a mode of transportation (McKinsey Center for Future Mobility, 2020) .33
Figure 7: Perceived health safety of mobility modes in % (Andersson, Gläfke, Möller, & Schneiderbauer, 2020) .........................................................................................................................................................33
Figure 8: Survey Results from the Question: Modal split before COVID-19 ..........................................................34
Figure 11: Percentage change of visitors to transit stations in different EU cities during the pandemic. (Source: Google COVID-19 Community Mobility Reports) ..............................................................................................................................................35
Figure 10: Survey result from the question: How has COVID-19 impacted the city’s mobility plans? .............36
Figure 11: Survey Results from the Question: Do you offer multi-modal ticketing due to COVID-19? ............37
Figure 12 - Attitudes towards air pollution (Posaner, Cokelaere, & Hernández-Morales, 2020) ...............45
Figure 15 - Virus chain in public transport ......................................................................................................50
Figure 14 - Future landscape and medium terms effects of the pandemic in the mobility industry ............52
Figure 17 - Impact of innovation and collaboration on city development ......................................................76
Figure 18 - Strategic objectives of EIT Urban Mobility Projects ........................................................................79
Figure 19 – Survey results from the question: How is the work with innovation organised in your city? ....81
Figure 20 - Survey Results from the question: Please specify the level of involvement of each stakeholder type .......................................................................................................................................................82
Figure 21 - Survey Results from the Question: How have citizens been actively involved/consulted in the change of the mobility strategy? ...........................................................................................................83
Figure 22 - Survey Results from the Question: After the COVID-19 crisis, please indicate if any of the following is being planned or identified as future needs concerning innovative actions in mobility? ........84
Figure 23 - Survey Answers from the Question: What role has data collection and analysis played in the mobility plans and, especially, during the pandemic? .................................................................85
Figure 24 - Survey Results from the Question: Is there a dedicated budget for innovation? ..........................89
Figure 25 - Survey Results from Question: How are the new actions being financed? .............................90
Figure 26. Change in consumers’ credit and debit card spending from 2019 for the week ending April 1. Circle diameter determines the size of the market (Source: (Leatherby & Gelles, 2020)) .......................... 102
Figure 27. Changes in purchase intention for different transport options (Source: (BCG, 2020)). ............... 107
Figure 28. Consumer price index average gasoline prices in the US (Source: constructed from U.S. Bureau of Labour Statistics data)................................................................................................................................................. 108
Figure 29. Median travel distance based on anonymous mobile phone location data (Source: (Gao, et al., 2020)) .................................................................................................................................................................................................................. 109
Introduction

The Virus SARS-CoV-2, also known as COVID-19 or Corona Virus, has spread in Europe in the beginning of the year 2020. The virus is generating a health and economic crisis, with especially new challenges for urban populations. The high contagion rate makes COVID-19 hard to control and drives international, national, and local governments to find solutions on how to tackle this crisis. One of the most important aspects of contagion is personal contact, which is very much present in urban citizens’ mobility. Thus, it is believed that the urban mobility systems, alongside with international travelling, have been among the most affected due to the pandemic crisis (Lozzi, et al., COVID-19 and urban mobility: impacts and perspectives, 2020).

Nonetheless, the changes in the requirements on urban mobility systems may not only be an issue, but also an opportunity to accelerate and/or create positive change. Before the outbreak of the COVID-19 pandemic European cities were shifting – and still are – their mobility paradigms. According to this report, the main challenges urban mobility is facing are climate change, urban health, social inclusion and cohesion, competitive economy, new models of governances and innovation technology. Correspondingly, this report has the aim to show how to harness the current crisis to create in the long-term more resilient and climate-friendly urban mobility systems.

In order to have a first-hand impression of the impacts from the pandemic in urban environments, a group of cities was surveyed and interviewed – find the list in Acknowledgments. The survey presents a broad diversity of European cities. The results need to be analysed in coherence with the survey design: First, the sample is small, and cannot be used for statistical analysis. Second, the survey was done during a period when the understanding of the effects of COVID-19 on different urban functions and systems was still in the early phases. Third, the survey covers topics that relate to different departments in a local government administration, and the respondents cannot be expected to know all aspects asked about. Forth, the answers must be seen in context, as the current starting point for a city will affect if a measure is seen as less or more innovative.

Therefore, the results should be seen as a snapshot of the situation, but they provide a general picture that can be used as basis for a qualitative discussion about effects from the pandemic and possible measures to take concerning actions, strategy and organisational issues. The results of the survey can be found in the 2, 3 and 4 Chapters. In addition, thought leaders in the mobility field were interviewed in order to support the findings of the report.

Lastly, with this report, it will be possible to understand the impacts of the pandemic on the status-quo of the urban mobility. At the same time, topics such as how cities and local governments deal with strategy and innovation are addressed. The economic and social impacts aggregated to the possible changes in the urban systems are evaluated and explained. And, accordingly, best practices from European and global cities are described.
1 Chapter: Challenges, requirements and strategies of sustainable urban mobility systems

1.1 Urban mobility: the pre-pandemic context

Urban mobility is a complex realm within the overall dynamics of cities. Many cross factors have an incidence on the ways people and goods move in urban environments and, in turn, such movements have huge impacts on the form, the function and the quality of life of metropolises, shaping activity patterns. In an evolving society, urban environment changes (Meyer, Jan Hoekstra, & Westrik, 2020). And therefore, the socioeconomic context also changes and evolves, leading to new challenges for urbanism and the need to update the requirements for urban mobility. The sustainable mobility paradigm focuses on citizens, it is user-centred, searching to adapt as much as possible mobility solutions to personal needs.

The European Union has undertaken for many years multiple initiatives to promote a sustainable urban mobility (from EU mobility portals like CIVITAS or Eltis to official documents and action plans from the European Commission). This European framework is the primary source of information in this Chapter. Then, the discourse is modulated by some scientific paper’s contributions and some reflections from the authors to point out emerging issues and debates on the overall picture.

As a first approach, this chapter proposes a synthetic overview of the challenge’s cities were facing in relation to mobility issues before the COVID-19 pandemic. Those challenges are translated into requirements for urban mobility systems. Then, it is considered that the strategies that cities and all stakeholders involved in mobility solutions were implementing to face these challenges and respond to the requirements. Even if the development and the structure of the chapter implies that challenges, requirements and strategies are presented in a sequential way, it’s always necessary to bear in mind that they are tightly interwoven with each other. As an outcome of the chapter, a table has been produced intended to show these multiple complex interactions.

To underline the pre-pandemic situation enables to better contextualise the impact of COVID-19 (developed in the following chapters), both from a quantitative point of view (the new requirements raised by the pandemic are a very small part compared to the whole mobility challenges) and from a qualitative perspective (which of the long-term strategies for a transition towards a sustainable mobility can be more affected by the short-term measures implemented to face the pandemic).
1.2 Challenges & Requirements of urban mobility systems

Six challenges for urban mobility systems have been identified (see Figure 1, below). And they are presented grouped in couples: two environmental (Climate Change & Urban Health), two socioeconomic (Reclaiming road space & Competitive economy), and two instrumentals (Governance & Technological Innovations).

1.2.1 The urgent need to face Climate Change and improve Urban Health

Climate Change is one of the most complex and urgent global challenges humankind has ever faced. In December 2019, the European Union has launched the European Green Deal to become the first neutral continent by 2050 with the aim to drastically reduce Greenhouse Gas (GHG) emissions. 23% of Europe’s GHG emissions are produced by transport. In 2017, road transport represented 72% of the whole transport emissions. It’s important to highlight that in the past three decades, most of the polluting sectors reduced emissions but it’s not the case of transportation (European Environment Agency, 2020). And currently urban mobility produces a significant part of those road transport emissions. Whatever the impact of the COVID-19 pandemic, the reduction of GHG emissions remains a central requirement of the transition towards a sustainable urban mobility (either by reducing the number of vehicles moving around or by spreading the use of clean vehicles).

The emissions by cars not only contribute to climate change, but they are also at the origin of air pollution. Traffic factors (like volume and speed of vehicles, congestion situations, and the kind of engines) influence the levels of air pollution directly. The concentration of Nitrogen Dioxides (NO₂), Particulate Matter (PM₁₀ and PM₂.₅) and Ground-level Ozone (O₃) are now generally recognised as the three pollutants that most significantly affect human health (European Commission, 2017). In 2018 up to 450,000 premature deaths were estimated in Europe (EU-28) caused by poor air quality, most of them in metropolitan areas. (European Environment Agency, 2020)

Altogether with air pollution that complicates many illnesses, a sedentary lifestyle is the other main source of contemporary urban diseases. It produces overweight, obesity and cardiovascular problems. And mobility is tightly related to sedentary behaviours. If a mobility pattern based on personal car travelling contributes to sedentarism, on the contrary, active modes of transportation (like cycling or walking) are effective ways to counteract it.

In turn, noise pollution (also produced by fossil fuelled vehicles) is acknowledged as a source of stress and inducing mental illnesses. About 100M of inhabitants in Europe are exposed to levels of urban noise superior to the 55dB recommended by health authorities.

It could be assumed that, in developed countries, since the birth of industrial cities until Second World War, infectious diseases were the main urban health concern. The lack of hygienic conditions in cities (both in the habitability of dwellings and the lack of qualified public spaces and sanitary infrastructures) was at the origin of the outbreak and spread of infections, the main cause of mortality at that time. Since the second half of the 20th century, the hygienic conditions being clearly improved, lifestyle diseases have become the central health issue (Gehl & Svarre, 2013). Sedentary behaviours, for instance, are related to diabetes,
obesity and cardiovascular problems. And a car-oriented society has been at the heart of such lifestyles having negative health impacts.

In this context, biocities (the positive effects of synergies between nature and urbanization) appear as the next step in the improvement of urban conditions. If in the past, ventilation and sanitary guarantees for the water supply and sewage were key, nowadays greening our cities contributes to reducing air and noise pollution, favours physical activity and mental health and makes them more resilient to some impacts of climate change (like the heat island effect, for instance).

This combination of diminishing the car dependency of our urban transportation systems (as considered the main source of heavy negative externalities) and re-naturalizing cities appears in Europe as a consolidated path to deal with Climate Change and Health issues related to mobility.

Last but not least, urban mobility raises the road safety issue. In 2018, traffic accidents caused 25,000 deaths in Europe, most of them involving vulnerable road users (like cyclists and pedestrians) and becoming an important cause of mortality among children and youngsters. (European Commision, 2019). To evolve towards safer integral systems is a goal that requires safer vehicles (more automated and connected), safer infrastructures (smarter and integrating innovative technologies) and safer use of roads (considering new phenomena like shared vehicles that users are less familiar with or the risk of using mobile devices). EU’s “Vision Zero” aims to approach almost no traffic casualties by 2030. (European Commision, 2020).

1.2.2 A societal choice: reclaiming road space for civic uses while ensuring a competitive economy

Besides the environmental negative externalities of many current mobility systems, the transition towards more sustainable ones is driven by a key idea: in car-oriented cities, road space for motor vehicles takes too much room. An example is the city of Barcelona, where 57% of the surface of the urban public space is destined for the circulation of the vehicle (roads) and only 43% for pedestrians (sidewalks). (Ajuntament de Barcelona, 2014)

The challenge is to move from car-oriented environments to people centred ones. The main requirement (undertaken for decades in many metropolises) is to reclaim road space to transform it in public space for other civic uses: public transport and active modes of mobility (wider sidewalks and promenades, bicycle lanes...), gathering places related to public facilities (for instance, calm areas in front of schools) or commercial activities (bar terraces) and green leisure places (increasing street trees and permeable pavements). The intended result is a general rise of the urban quality of life by livelier, human scale, slow speed and ecological cities. They are also expected to be inclusive: accessible, welcoming and friendly for all social groups, whatever their specificities (age, gender, incomes, disabilities...).

However, cities can not only be seen as places for personal and social fulfilment. They are also the engines of our economies. 85% of Europe’s Gross Domestic Product is generated in cities. Urban mobility is a key factor for economic competitiveness: the availability of mobility solutions, their price, their quality and efficiency influence it. If a fluent reliable mobility system fosters competitive economies, transport congestion is a main threat to them. Losses due to traffic congestion in Europe are estimated up to 123 billion euros per year. And congestion has also negative social effects. The time spent in commuting is a
heavy toll for many metropolitan dwellers and users. Congestion involves both a waste of money and time. (European Commission, 2018) (Commission of the European Communities, 2009)

To balance the aim of reclaiming road space to create liveable cities and the necessity to ensure efficient mobility systems for competitive economies is one of the crucial challenges of the whole urban mobility transition. Most of the ongoing strategies pursue this goal. To reduce the space for private motor vehicles without providing effective alternatives involves serious risks of social (neighbours and commuters) and economic (business operators) discontent and disapproval. In particular, the solutions in order to improve the mobility of goods, the urban freight transportation, appear as a critical field.

In that sense, there are some socio-economic phenomena that influence this balance between reducing cars and guaranteeing fluent flows. Furthermore, the culture of sharing goods and services. The access to and use of a good or service is increasingly valued over ownership in several population ranges (Hamari, Sjöklint, & Ukkonen, 2015). The spread of sharing schemes for mobility devices (like bikes, scooters or cars) or the clear decrease of the private car as a status symbol are symptoms of such a trend (Belk, 2014). These mental collective shifts are important, because car reduction cannot be enforced top down following a strictly technical vision, but it needs to be based on social debate and consensus, taking into account the right of free choice of citizens and economic stakeholders (and cars continue to be appreciated as one of the most comfortable means of mobility). (Willing, Brandt, & Neumann, 2017)

Likely, the emerging forms of a collaborative economy can help to explore new mobility solutions. More complex and fruitful synergies between different stakeholders (public administrations, private businesses, community initiatives, and particular users) make it possible to develop business models better adapted to the complexity of urban mobility requirements from the socio-economic perspective.

1.2.3 Governance & Technological Innovations as enhancing opportunities

The above-mentioned complexity of the environmental and socio-economic challenges that urban mobility is facing can only be tackled through innovation. Innovation in governance practices appears to be as important as technological innovation itself.

The innovation in governance turns around a core issue: the need to develop more complex (and effective) mobility ecosystems involving multiple stakeholders cooperating together. Cooperation between different departments in the same public administration is never easy and not always achieved (the risk of silo working pointed in the 4 chapter of this report). Then, the goal of making municipalities, private transport providers, social communities and individual citizens’ work together in search of new mobility solutions becomes a huge challenge.

Citizen’s participation and empowerment are crucial. People’s engagement in the mobility transition can be considered from a triple point of view: as citizens, users and agents. First, involving citizens is key to building a truly shared collective vision for the future of urban mobility, as said, a necessary condition to implement changes. Participation processes of urban planning and place making initiatives are widely spread, but also are communication campaigns to raise awareness of the challenges facing mobility.
Second, to collect the feedback from transport services’ users is more and more useful to improve them. The development of civic interactive online platforms is helpful in that sense (CIVITAS2020, 2019).

Third, people are true actors of some cooperative and collaborative business models (like in ridesharing) or new mobility solutions (like on demand flexible public transport services). Cooperation with social enterprises or a social entrepreneurship approach from public and private stakeholders makes it possible to carry on field experiments enabling co-creation dynamics and leading to develop innovative and disruptive solutions. The traditional public-private partnerships are being extended to include social communities, blurring the rigid boundaries between different stakeholders and launching true collective transport solutions.

In order to achieve this intermingling of stakeholders, to grant access to data on mobility is basic. This needs the development of interfaces, enabling to share data and treat it. It is a sensitive issue: the privacy of users’ behaviours or the confidentiality of any corporate information must be preserved.

In this context, regulations emerge as a pivotal aspect of governance. Some regulations directly affect the use of urban environments (for instance, parking management or the regulation of new technologies like e-scooters or automated cars or new mobility services like shared vehicles). However, strictly governance regulations become urgent, in order to suppress legal barriers for cooperation between stakeholders or to set guarantees for data protection encouraging stakeholders to share it. To move towards a harmonization of European and local policy-making in order to achieve a unique transport sector legislation it’s also a relevant issue. The Finish Action Transport Services (2017) provides a good example of this new kind of legal framework (Future Mobility Finland, 2020).

Another important aspect of the governance challenge is related to finance. On the one hand, pricing (road charging), subsiding (clean vehicles) and taxing (carbon fuels) measures are essential strategies to internalise the external costs (environmental and socioeconomic) of transport. They are schemes applying the polluter-pays or user-pays principles and they can be very effective in regulating the presence of cars in cities (European Commission, 2018). On the other hand, the growing needs for funding complex transport systems and the likely decrease in the availability of public financing are the main challenges (Commission of the European Communities, 2009). Again, public-private partnerships need to be enhanced to increase the contribution of private stakeholders in funding collective mobility solutions.

The EU eagerly promotes Sustainable Urban Mobility Plans (SUMP s). They can be useful governance tools (ELTIS. The Urban Mobility Observatory, 2020). SUMP s propose comprehensive, integrated, long-term visions for urban mobility transitions. Comprehensive because they interweave different scales (cities being interconnection points between trans-European and regional transport networks and last-mile movements of goods and passengers) and cross disciplinary fields (relating mobility to urban planning or ecological approaches). Integral because they overarch the whole planning process, from a fact-based assessment to the monitoring of the effects of the implemented strategies. Besides, strategic approaches are central to SUMP s: they offer a means to debate, discussion and agreement between public authorities, citizens and private stakeholders. They seek cooperation across institutional borders, citizens’ involvement and synergies between the whole mobility ecosystems.

Technological innovation is a permanent driving force for changes in our societies. During the 20th century, technological progress in the automotive sector has led to car-oriented cities (second industrial revolution).
Instead, in the 21st century technology is expected to help the mobility transition towards people-centred urban environments. In this manner, digitalisation, globalisation and the energy transition have resulted in a third industrial revolution. (Meyer, Jan Hoekstra, & Westrik, 2020).

Data collection and analysis is at the core of current technological innovation on mobility. It enables to create models and support tools for cities to make decisions on urban planning or mobility strategies and monitor the results. It makes possible the development of Cooperative Intelligent Transport Systems (C-ITS) capable of managing the transport dynamics based on real-time data and favouring more flexible uses of transport infrastructures and services. In accordance, the digitalization of vehicles and infrastructures is a main trend. Connected vehicles and roads will be able in near future to share amounts of data to users, other vehicles or the ITS, becoming useful tools to reduce congestion and increase safety. Finally, innovations on cars and infrastructures can make other contributions, like improving energy efficiency (clean vehicles) or increasing the comfort and safety of users (automated vehicles). Such technological innovations could drastically reduce the negative externalities of cars and have an impact on the vision of future mobility itself, at this moment oriented to their reduction in cities.
Figure 1 - Challenges & Requirements for Urban Mobility systems
1.3 Strategies for the transition towards sustainable urban mobility

Cities and all stakeholders involved in mobility solutions deploy many strategies to respond to the challenges and requirements for a more sustainable urban mobility. In this section, such strategies are presented grouped into three categories: urban planning actions / intermodal transport systems integrating automotive innovations / changes in the design and regulation of public space.

1.3.1 Proximity Urban Planning

Urban planning plays a key role in the management of urban mobility. Both spatial planning and urban form determine the transport network. However, in recent years, urban planning is also affecting urban mobility in a broader manner, because it is questioning the idea of commuting, zoning and the promotion of fast mobility. Nowadays, urban planning has turned out to be more centred on minimizing the impacts of mobility, to reduce the need for commuting, and to incorporate the citizens as stakeholders of the planning process. New urban planning tends to think about more accessible cities for every citizen using new technologies, such as Big Data analysis.

1.3.1.1 Accessibility versus Mobility

The best journey is the one that can be avoided. This sentence reminds us that the main goal of a mobility system is not to move around, but to ensure the accessibility of citizens to all the goods and services a metropolis offers. If the location of dwellings, jobs and services are strategically coordinated to favour proximity, journeys can be reduced. And urban planning plays a major role in this land-use distribution.

Indeed, sustainable mobility has its main goal in improving the accessibility of goods and users. This conceptual change has incorporated the availability of people as a key factor in mobility studies (European Commission, 2013). Besides, accessibility could be applied to our cities from two different perspectives. (European Commission, 2017)

The first perspective is the one that promotes accessibility for people and goods to the transport network from all scales: local, regional, national and international. This means that to enhance social justice, there is a need for improvement not only of the system itself but also of access to it for all citizens, services and goods involved in a network. As an example, this perspective can be complemented by the analysis carried out by Space Syntax, which analyses the accessibility of an urban network from a topological point of view and measures its integration and depth distance. (Stonor, et al., 2020)

The second perspective of accessibility is the one that enhances the access to the urban transport system of people with disabilities, reduced mobility or senior citizens. This approach points out the challenge of performing more inclusive and fair cities, reinforcing the social justice of vulnerable people. Accessibility plays an important role in Sustainable Urban Mobility Plans because they aim to provide high quality and sustainable mobility transport to, through and within an area for all kinds of citizens, especially the more vulnerable.
Accessibility as a concept introduced into urban planning implies a shift to a more inclusive city, which not only deals with the movement of people but with their right to access the transport network as a holistic system.

1.3.1.2 “15-min city” neighbourhoods

Some of the strategies that are being applied in our cities change the general concept of planning. This is the case of the “15-min city” neighbourhood. The 15-min city aims to increase the proximity between people’s homes and their daily activities, thanks to the promotion of diverse neighbourhoods. This implies a paradigm shift to diversity, mixture of activities and coexistence of different functions fostering liveability. The 15-min city reinforces urban life: walkability, culture, sport, markets, proximity commerce, artisanal activities and schools. It reduces travel distances between home, daily activities and all kinds of amenities. (Balducci, 2020)

The main characteristic of the 15-min city is the creation of partially autonomous sub-centralities that make neighbourhoods more self-sufficient and distributes services equally within the city.

In terms of land use and urban form, it has also implications because it promotes the fine grain of plots and buildings. This is to say the promotion of equality, the humanisation of the scale of the city and a more decentralised urbanity.

In terms of urban mobility, the 15-min city aims to reduce commuting distance and forced mobility. The reduction of daily journeys could imply changes not only in urban mobility as a feature of the city, but a reduction of the space for vehicles. Indeed, the paradigm fosters the walkable city, because it aims to cover a great number of necessities in a 15-min walking distance. Moreover, the promotion of walkability as a requirement has a positive impact on ecologic challenges (such as emission reduction) and health (favouring physical activity).

EXAMPLE 1 - Ville 1/4h Paris: The municipality of Paris is applying a planning programme called “la ville du quart d’heure”, which aims to incorporate the 15-min city approach in a broader perspective of the circular economy.

Photo Credit Steven Lasry (2020)
EXAMPLE 2 - Superblock Barcelona: The grid of Barcelona in “L’Eixample” pretends to be transformed into a new super-grid. Within each superblock walkability is reinforced and tends to incorporate the services needed by the citizens residing in it.

Photo Credit Kaspars Upmanis (2020)
1.3.1.3 Big Data analysis applied to urban planning

The accessibility to smartphones of all citizens has generated a huge amount of data that is permanently analysed. In urban planning and management, the visualization of data is a source of knowledge. This implies the generation of new methods and technologies to collect, analyse and represent real-time user-generated data for promoting more participatory planning and management processes. In urban mobility, the data sets could be small data, such as “travel behaviour analysis” or big data, such as “human mobility analysis” (Ciuccarelli, Lupi, & Simeone, 2014). However, it is a matter not only of analysing data but also of decision making. This new framework of observation embeds citizens into an advanced engagement in mobility policies. There is a shift in the paradigm of decision-making. Real-time data could modify real-time planning decisions and mobility is one of its more flexible features (Chen, Ma, Susilo, Liu, & Wang, 2016).

The increase of knowledge that citizens are acquiring thanks to this double role of the generator and planner of data, is empowering them to take a leading role in the conception and implementation of mobility plans to improve transport systems.

**EXAMPLE 1 – WeCount: Madrid, Ljubljana, Dublin, Cardiff and Leuven:** The WeCount project fosters the empowerment of citizens to generate data and knowledge about their own neighbourhoods, while they are living them. The project is applying participatory citizen science methods to co-create innovative low cost, automated road traffic counting sensors and multi-stakeholder engagement mechanisms. [https://www.we-count.net/about](https://www.we-count.net/about)

Photo Credit WeCount (2020)

**EXAMPLE 2 – MOMENTUM:** «Modelling Emerging Transport Solutions for Urban Mobility. Aims to develop a set of new data analysis methods, transport models and planning support tools to capture the impact of these new transport options on the urban mobility ecosystem, in order to support cities in the task of designing the right policy mix to exploit the full potential of the emerging mobility solutions». URL: [https://h2020-momentum.eu/about/](https://h2020-momentum.eu/about/)

Image Credit MOMENTUM (2020)
1.3.1.4 Urban logistics planning

Urban freight transport (UFT) is one of the most critical components of any mobility system. On the one side, it is particularly unsustainable. The transport of goods in cities produces heavy negative externalities: it pollutes (it accounts for 25% of urban transportation CO\textsubscript{2} emissions and for 40% of other pollutants) and it is one of the main sources of congestion and traffic accidents. On the other side, urban logistics is a fast-developing industry (with the exponential increase of e-commerce) on which many other economic sectors depend. Economic competitiveness greatly relies on efficient urban logistics.

Planning urban freight transport does not follow the same principles and rules as planning passengers' mobility ( NOVELOG project, Georgia, & Xenou, 2019). The main difference is that many private stakeholders compete in the logistics market and public authorities don't lead it as they do with the public transport system, for instance. In logistics, governance is even more decisive. For any freight planning initiative, it is crucial to engage stakeholders from an early stage, in order to overcome the difficulty of data sharing and to promote collaborative schemes.

**EXAMPLE 1 – NOVELOG; London, Pisa, Copenhagen, Venice, Gothenburg, Emila Romagna Region:** «New cooperative business models and guidance for sustainable city logistics. Aims to enable knowledge and understanding of urban freight distribution and service trips in order for cities to implement effective and sustainable policies and measures and facilitate stakeholder collaboration for sustainable city logistics». URL: [http://novelog.eu/](http://novelog.eu/)

Many measures have been explored in the last decades to improve urban logistics (CIVITAS WIKI, 2015). Regulations can affect time (in order to flat the delivery peak hours, by promoting night silent deliveries, for instance) or space (regulating the sharing of parking places with loading/unloading areas or the shared use of public transport lanes for cargo movements). Pricing can condition the routing of freight vehicles in a dynamic way depending on congestion conditions and taxing can incentive investments in clean vehicles. Urban logistics tends to a high degree of digitalisation. New technologies can adapt Intelligent Transport Systems to dynamic routing of trucks and vans and clean cargo vehicles are being developed (including the use of drones).

However, a crucial aspect is to provide loading/unloading physical spaces in the city. This includes traditional on-street areas, off-street areas in buildings with intense commercial functions (like municipal markets or shopping malls) or collection points where users can receive their goods in a centralized manner. The most sophisticated measure is to create urban terminals where the transfer between long-
distance freight and last-mile takes place and that promotes cooperative logistics through joint delivery schemes between different operators.

The optimal blend of these measures depends on each city's features, like the extension of the metropolitan functional area, the urban structure and patterns or the typology of supply chains.

1.3.2 Seamless Intermodality

In a vision of sustainable urban mobility that involves the reduction of cars in urban areas, intermodality constitutes the backbone of the transportation model. A combination of different modes of transport depending on the momentary needs of each citizen is the alternative to personal car travel.

First, intermodality requires efficient modes of transportation able to complement one to each other. Second, intermodality requires mechanisms to make seamless (smooth, affordable, time saving) the combination of these multiple mobility services. Third, intermodality should deal with the effects of the automotive technological revolution in order to benefit from them rather than seeing them as a threat for favouring personal car use.

1.3.2.1 Complementary modes of transportation

The existing mobility services are the departing point of integrated mobility systems. Public transportation is the cornerstone of any intermodal mobility system. To develop high quality public transport solutions (reliable, with clear available information, safe, easy access and affordable) is vital for making attractive bus, metro, tram, rail or urban ship services. In the last years, the improvement of public transport has focused more and more on users' expectations. Collecting their feedback becomes essential and this approach leads to the development of more flexible on demand solutions.

Shared mobility is an emerging actor in the system of multimodal transportation. Altogether with public transport, these services are known as collective transport. They include the fleets of shared vehicles (cars, motorbikes, bikes, scooters...) but also business models of ridesharing (when different users combine their journeys, sharing the same vehicle) and car-pooling (looking to maximize car occupancy). The market for shared mobility services is in clear expansion and has a role in the necessary diversification of the automotive industry.

Bicycles (and other personal mobility means, like scooters) rise as a key component of sustainable urban mobility systems. If the conditions of the mobility ecosystem are favourable, bikes are competitive for rides between 10 and 20 km and a high percentage of the commuting journeys are in this range. Then, travelling by bike can be the perfect complement to the use of public transportation. A favourable ecosystem means multiple requirements: a bike friendly urban environment, either with a connected (without discontinuities) network of bicycle lanes or with areas of safe shared space between bikes and pedestrians (10 km/h) or between bikes and cars (30 km/h); a network of interurban express bike lanes enabling to commute at the metropolitan level; a flexible service of bike sharing, offering multiple modalities (in terms of duration of the location and types of bikes, including electrical ones); a system of safe bike parking strategically located and integrated with other modes of transportation.
Last but not least, walkable urban environments are invaluable assets of any intermodal transportation system. Any door-to-door journey involves a minimum of street walk and the quality of this experience appears as a determinant factor to choose between multimodal solutions or personal car travelling. The transformation of our neighbourhoods into pedestrian friendly areas arises as a mobility strategy in itself (see section 1.2.3 about the redesign of public space).

### 1.3.2.2 Integrated Mobility Systems

Multimodal transport urban systems aim to combine the above-mentioned modes of transportation in order to exploit the advantages of each one. If this combination becomes seamless, then it has competitive advantages compared to personal car travelling. Seamless means efficient in planning the journey (from getting the information necessary to make our travel choices to booking services when needed), in travelling (with comfortable mobility services and smooth interchange between them) and in paying for it (with integrated ticketing). The advantage of an intermodal system is that it can be tailored to the user’s needs and wishes. The user can choose at any moment the travel combination following different criteria: the fastest, the cheapest, the most environmentally friendly, even the most scenic... When efficient, intermodal solutions can be cheaper and therefore more affordable and inclusive. But to develop seamless intermodal systems requires a lot of innovation. In some way, they are still in their infancy. (CIVITAS2020, 2019). (Willing, Brandt, & Neumann, 2017)

Mobility as a Service (MaaS) emerges as a response to achieve seamless intermodality. It could be defined as the integration of various existing mobility services providing them to users via a single means (namely, a digital platform). Seamless intermodality is therefore an intelligent system, implying the use of real-time place-based data and connectivity (the reception and transfer of data). The advantages of such digitalisation are multiple: it makes shared services and combination of transport modes, it decreases waiting times and optimizes mobility services in suburbs, rural areas or during off-peak hours. However, challenges and barriers to reach such multimodal integration are important. Moreover, governance, as previously mentioned (section 1.2.3), is at the centre of the whole sustainable urban mobility transition. In order to implement intermodal systems, the active engagement of multiple public and private stakeholders is necessary. Public Transport providers try to become MaaS operators in order to control its potential, but other schemes are possible (Hirschhorn, Paulsson, Sørensen, & Veeneman, 2019). To share data from different stakeholders and make it available to users in a unified way or to centralize ticketing when the fee structures of providers differ are two common issues difficult to solve. And the concern for interoperability goes beyond governance: it implies the Information and Communication Technologies themselves (how different digital applications and platforms can interact), as well as the energy systems and infrastructures that should support several transport modes. (World Economic Forum, 2018); (ERTICO – ITS Europe, 2019); (Future Mobility Finland, 2020)
EXAMPLE 1 – WHIM MAAS GLOBAL, Helsinki: «It's the first all-inclusive MaaS solution commercially available on the market, gives its users all city transport services in one step, letting them journey where and when they want with public transport, taxis, bikes, cars, and other options, all under a single subscription. MaaS offering delivers the best of each form of transport, by leveraging technology and connectivity to meet changing consumer preferences. In Helsinki there are different plans to choose (Whim Urban 30, Whim Student 30, Whim Weekend and Whim Unlimited) ». URL: https://whimapp.com/

To adapt physical infrastructures to intermodal solutions means to develop a new generation of mobility hubs. If traditional intermodal hubs were functioning around public transport nodes, in contemporary ones, shared mobility becomes a pivotal added asset (that can complement public transport stations, but also be located in transformed car-dealers, public parking or fuel stations). Such mobility hubs are not only places of interchange between transport modes, but they can host multiple complementary services. Some of these services are mobility related (charging, repairing, cleaning, customizing vehicles), but many others can respond to wider users’ demands (from coworking rooms to cultural exhibition places, from deliveries collection points to proximity food markets). To conceive business models able to provide services adapted to the profiles of users is a challenge for the development of mobility hubs. It strengthens their economic viability. Besides, when these business models take into account the needs of the surrounding social community, mobility hubs can become true civic gathering places and add urban value to neighbourhoods and cities (Moreno Sanz, et al., 2020). To understand both the daily mobility patterns of multimodal users and the socio-economic features of the near neighbours is key. Through these complementary services, mobility hubs can function as logistic nodes (points for delivery-collection of goods) and environmental nodes (points for distribution of clean energy or waste collection and recycling). Finally, depending on their metropolitan location, the size and role of mobility hubs will vary. Urban hubs are offering more proximity services, while suburban hubs are more able to articulate (through park & ride solutions) the personal car use with the intermodal system expected to become dominant within metropolitan areas.

1.3.2.3 Automotive revolution

While the proximity urban planning and the development of multimodal mobility systems intend to reduce the use of cars, the automotive industry advances in a technological revolution, producing clean, automated, connected and safe vehicles. All these changes greatly contribute to minimize the current negative externalities of car use.

The electrification of mobility systems (Polis & Rupprecht Consult, 2019), can reduce the main problem of GHG emissions, but it faces three major barriers: electrical vehicles still have a high cost, the network of recharging stations is insufficient and, as a result, the level of customer acceptance is low. Then the solution not only requires technological innovation to reduce the cost of clean vehicles, but also a better interlinking between the energy system, road infrastructures and transportation modes. The electrification of public transport systems is a necessary starting point.
Connected Automated Vehicles are inseparable one from the other. While the development of Intelligent Transport Systems can reduce congestion, automated vehicles can induce important sociological changes, as cars can be seen and lived as habitats (for working, for leisure) and commuting time stops being a waste of time. Besides, the automation and connectivity of vehicles can also reduce driving human errors and increase road safety.

**EXAMPLE 1 - CCAM:** “Cooperative, connected and automated mobility. Today's vehicles are already connected devices. In the very near future, they will also interact directly with each other and with the road infrastructure. This interaction is the domain of Cooperative Intelligent Transport Systems (C-ITS), which will allow road users and traffic managers to share information and use it to coordinate their actions.” URL: [https://ec.europa.eu/transport/themes/its/c-its_en](https://ec.europa.eu/transport/themes/its/c-its_en)

**EXAMPLE 2 - CIMEC:** “Cooperative ITS for mobility in European Cities. It was created to support the efforts of the European Commission in accelerating the take-up of Cooperative Intelligent Transport Systems (C-ITS) and associated legal, organisational, technical and standardisation issues. Aims were to understand potential benefits and impacts of cooperative intelligent transport systems (C-ITS) on urban environments. Many connected services require information from the vehicle, which puts a significant burden on data protection. CIMEC suggests that initial deployments are likely to focus on professional drivers in managed fleets (e.g., public transport and freight).” URL: [https://civitas.eu/sites/default/files/policy_brief_satellite_transport_telematics_feb_2018.pdf](https://civitas.eu/sites/default/files/policy_brief_satellite_transport_telematics_feb_2018.pdf)

If the aim of reducing personal car use is central in the sustainable urban mobility transition envisioned (as cars are not only source of emissions, congestion and accidents, but also of sedentary behaviours and occupy public space), improvements on vehicles technology should be put at the service of better public transportation, urban logistics and shared mobility services. Then the reconversion of the automotive industry, a pillar of our economies, is unavoidable and urgent.

### 1.3.3 Public Space Redesign

Public space is a limited multipurpose and extremely valuable urban asset. The shift to a more sustainable mobility has a direct impact on it due to its natural relationship with roads and other spaces used by vehicles. The relation between public space and mobility is a bidirectional interaction: changes in one modifies the other. This is to say that changes produced in mobility affect our public space and changes produced in public spaces affect mobility. A more inclusive and accessible public space requires new modes of transportation and new modes of transportation might need changes in public spaces.

One of the goals of the transition towards sustainable mobility is that cities might recover plenty of public space that used to be dedicated to cars, motorbikes and other vehicles. This recovered space might be shifted to many other uses (space for pedestrians and bicycles, places for leisure and social activities, greening areas...). This may generate a public discussion to decide how citizens might use the reclaimed space.
1.3.3.1 Tactical Urbanism

The rapidity of changes in cities and the consequent need of fast responses has introduced the concept of tactical urbanism into the redesign of new urban spaces. Tactical urbanism aims to respond to the needs of local communities with cheap and temporal proposals that help to test new urban strategies by fast transforming urban spaces. The main features of this type of intervention are low-cost, small-scale and temporal proposals. These projects promote the intervention of neighbours in the building of public space, which directly improves its liveability. (Lydon, et al., 2012)

In terms of urban mobility, tactical urbanism has been used to reclaim the space used by cars for other uses, such as terraces, gardens, public spaces, squares, etc. Most of these interventions aim to gain space from roads by extending walkable, cyclable, playable, enjoyable and peaceable public space. This type of temporary intervention could last hours, days or years, depending on the acceptability of the proposals and the involvement of all agents (citizens and administrations). Tactical urbanism involves citizens as end-users and aims to search rapid solutions for reclaimed spaces, while testing the proposals in a real-life environment.

Tactical urbanism is also related to the new concept of Living Labs, which are emerging from the cooperation between different agents (local communities, administrations, researchers/designers and industry) to transform cities. Some of the projects that are part of Living Labs are improving the quality of urban spaces by re-shaping urban mobility using tactical urbanism. This is to say, a real experiment in urban space and a challenge for a new kind of governance.

EXAMPLE 1 – FURNISH: Barcelona, Budapest, Espoo, Guimarães, Milan: FURNISH (Fast Urban Responses for New Inclusive Spaces and Habitat) aims to merge the challenge of having more public spaces through ‘tactical urbanism’, which can reconfigure a street, expanding the space for pedestrians and leisure, with local digital manufacturing, through the quick and effective deployment of urban elements in a neighbourhood. URL: https://furnish.tech/
EXAMPLE 2 - CLEAR. City LivEAbility by Redesign: Amsterdam, Barcelona, Milan, Munich, Stockholm, Stuttgart, Tel Aviv - Yafo: CLEAR is a platform of real-life experiments in urban streets with small, tangible interventions that include a new vision of urban mobility. URL: https://www.streetexperiments.com/
1.3.3.2 Parking and road space regulation

Regulation of the use of public space is almost as important as its design. Parking regulation is one of the big issues. Cars spend about 95% of their time parked rather than moving. Then, while stationing is always difficult in central cities, on-street parking consumes a lot of public space. Reclaiming road space is both reducing car lanes and diminishing car park places.

Parking regulation is one of the keys to manage urban mobility and travel demand. Firstly, to limit and price parking is one of the most effective measures to reduce cars in cities and address the challenges of sustainable mobility. Furthermore, it has an impact on the transport sector as a whole and on its externalities. By the reason of the fact that the price of parking affects the price of any other good. One feasible thing is to avail the parking revenues raised to compensate those negatively affected. (Albalate & Gragera, forthcoming). At the same time, these are usually unwelcome measures for citizens. Parking becomes a scarce expensive service. The reason is because public space has so much value that you have to pay to occupy it. (CIVITAS2020, 2020)

- **EXAMPLE 1: PUSH&PULL Tarragona**: “Parking management and incentives as successful and proven strategies for energy-efficient urban transport”. URL: [https://www.europeanparking.eu/media/1391/pp_project_brochure_final_en.pdf](https://www.europeanparking.eu/media/1391/pp_project_brochure_final_en.pdf)

Secondly, innovative technology-based parking management solutions is the other important measures to implement an integral parking management that help with monitoring occupancy levels, making seamless payment and facilitating regulation enforcement. (Albalate & Gragera, forthcoming).

In terms of regulation, another important issue is to manage shared spaces, establishing time schedules between different uses (places that can be used sometimes as parking, sometimes as loading/unloading areas; lanes that can be used in some hours for public transport, in others for urban freight...). In an Intelligent Transport System, such regulations can be dynamic depending on the traffic congestion.

In addition, the emergence of automated vehicles (AVs), although not a current reality (the technology already exists, but the timing of its implementation is still uncertain), is a virtual possibility that would contribute to liberate road space in cities. Connected AVs would be more driving efficient and could move closer to other vehicles, reducing the need of road space and shared automated vehicles could be moving most of the time, diminishing the need for stationary space.

The introduction of AVs raises many questions, especially about regulations, tests of viability and insurances capability. However, the importance of the impact that its implementation could have on cities, has conditioned the perspectives of planners and decision-makers in relation to the space traditionally used by vehicles. The first new perspective aims to evaluate the impact of AVs in the space of moving, that might be reduced thanks to the implementation of shared mobility. The second perspective aims to analyse the possible reduction of stationary space. This position implies that cities might recover plenty of public space that used to be dedicated to cars, motorbikes and other vehicles. (González-González, Nogués, & Stead, 2020).

The availability of this space opens the possibility of increasing the space for pedestrians and bicycles. Indeed, this recovered space might be shifted to many other uses. This may generate a public discussion
to decide how citizens might use this recovered space. Moreover, there is a commitment of promoting mixed-used areas and the extension of public and civic spaces that should derive in the redesign of urban spaces. The emergence of AVs and the new parking regulations is a clear challenge for the local governance and their policies, as well as for reclaiming new inclusive and liveable public space for citizens.

1.3.3.3 Public Space as a green infrastructure

From the merge between the fight against climate change and the aim of producing more liveable cities emerged the biocities concept. This intention of overlapping urban and natural spaces incorporates many new concepts such as the green infrastructure. The green infrastructure aims to link all ecological areas within the city (parks, gardens, lanes of trees, etc.) as a whole and a unique system that is interconnected and overlapped. Besides its general conception, the green infrastructure can be planned in urban environments to promote human integration, ecological sustainability and economic regeneration.

Considering green spaces as a basic network and system for the city implies direct intervention in urban spaces. Some public spaces were not designed to incorporate green areas and may provoke a lack of connectivity within the green infrastructure. To integrate the concept that urban and regional planners are applying to cities, some public spaces should be redesigned. In this case, the redesign of public spaces is part of a major strategy in a planning scale and it is crucial to produce overlapping green spaces. Besides, the redesigned public space aims not only to become part of the ecological system of the city, but also to promote more inclusive spaces for all citizens and especially for the vulnerable ones.

- **EXAMPLE 1 - Redesign of Passeig de Sant Joan, Barcelona:** El Passeig de Sant Joan is a major street in Barcelona that was redesigned in 2013-2014 by the architect Lola Domènech. The design of the pavements incorporated new green spaces because the street was considered a main axis in the green infrastructure of the city from the seafront to the Mountains of Collserola.
1.4 To start a discussion: two hypotheses

This chapter has presented the main challenges, requirements and strategies for sustainable urban mobility in Europe in order to evaluate in the next chapters how they have adapted in the short term to COVID-19 and what can be the long-term impacts due to the pandemic. As exposed, the challenges of urban mobility generate present and future requirements that are translated into a variety of strategies.

In a first glimpse, it seems that cities are not reconsidering their long-term mobility strategies (first hypothesis), but on the contrary, using the COVID-19 measures to foster some of them (second hypothesis).

For one thing, the requirements coming from the pandemic appear to be temporary and partial. The impacts of COVID-19 can be more or less lasting (stronger habits of cleanliness, psychological apprehension to be close to other people, sociological patterns like remote working, the effects of the economic crisis...). But the direct requirements for social distancing (with all its impacts on public transportation and the use of collective places) will disappear as soon as vaccination is available and extensive. Indeed, put in the context of all the above-mentioned challenges urban mobility systems are facing, COVID-19 requirements represent a small part.

Therefore, the experience of dealing with COVID-19 pandemic enables our societies to learn many lessons to deal with hypothetical future situations of infectious diseases (as Asian countries like Taiwan or South Korea, with the SARS-Cov-1 outbreak during 2002-2004, the first strain from the current COVID-19/SARS-Cov-2 (Business Insider, 2020), already did), but it should not deeply change the overall vision of future urban mobility systems. As exposed in 5 chapter of this report, this vision of sustainability can be in tension with real dynamics of our economies and societies. Nevertheless, the vision defined by the challenges and requirements is a driving force (intended to be the leading one) for the transition towards sustainable urban mobility.

In Europe, the Sustainable Urban Mobility Plans (SUMPs) that represent a space for debate and new governance could implement all strategies summarized in this chapter. SUMPs should take into account the possible new tensions that the COVID-19 has generated in the mobility of our cities, as a necessary tool that might be able of reacting in front of non-planned situations, as such.

In the next chapters, based on the analysis of best practices and information provided by cities through a survey, this report tests and reflects on the following hypothesis: mobility policies to respond to the COVID-19 pandemic emerge as an opportunity to accelerate the envisioned transition towards sustainable mobility.
2 Chapter: Effects of COVID-19 on Urban Mobility Systems

In addition to the mobility challenges and requirements mentioned in the chapter, the COVID-19 pandemic brings in new challenges and requirements. The need for social distancing as one of the main ones, it has effects in many aspects of our urban life. First, it questions the benefits of urban density, considered a central parameter of sustainable city models. Second, it shows the limited and sometimes scarce amount of public space in compact cities (space for leisure, but also space for moving by walking or cycling). The temporary increase of pedestrian space (by closing some road space to motorized traffic), the regulation of street space use (with pedestrian ways in one single direction) or the regulation of time access through time slots have been some short-term measures implemented to optimize the use of public space.

Public transport has been particularly hit by social distancing, losing one of its great advantages: the capacity of moving crowds. With less resources due to the decrease of ticketing, an increased frequency and a responsibility to ensure high standards of hygiene, public transport providers have been challenged across Europe. For shared mobility, cleanliness is a main issue too. Remote working appears as a basic measure in order to reduce commuting and flatten peak hours, the main way to limit the stress on public transport and make it work under the new conditions.

Last but not least, social inequalities appear to be closely related to the pandemic spread. COVID-19 has more impact in low-income neighbourhoods, where the average number of inhabitants per dwelling is higher, the share of the population with qualified jobs that can work remotely is lower and most commuters continue to use public transport regularly. The risk of contagion in these areas is obviously higher.

This chapter describes the impacts of COVID-19 according to the survey presented in the Introduction and related literature. Additional considerations and changes affecting mobility systems are discussed including their consequences and challenges. Also, the public sector measures are explored in order to give a glimpse on possible outcomes, present and future perspectives of the urban mobility.

2.1 Impacts of COVID-19 in Urban Mobility Systems

The COVID-19 pandemic has significantly impacted urban life, trade, and commerce. The need for social distancing to restrict the spread of the virus has limited movement of people globally as well locally to unprecedented levels. Routine activities such as working, studying, socialising, shopping, etc. which required day-to-day commute are now being done conveniently and securely within the four walls of home. In European cities, where the reliance on shared and public transit was higher in pre-pandemic times, the pandemic has transformed mobility significantly. While certain impacts might be restricted to the
lockdowns and the pandemic, there is high level of uncertainty on the medium- and long-term impacts of the changes.

This section explores the immediate impact caused by the pandemic on mobility in European cities. For specific insights from cities, a survey (with 16 cities) as well as 8 interviews have been conducted with city representatives and leading experts in the field of urban mobility. Based on this the transformation of urban mobility due to COVID-19 will be discussed under the following three categories:

- Change in mobility demand
- Shift in user requirements
- Decrease in investments in mobility

2.1.1 Reduced demand for mobility

Restrictions lead to reduced need for traffic volume. The modal split has not only shifted during the pandemic but due to the increasing share of people working from home and travel restrictions, also the overall demand for urban mobility has significantly decreased since the start of the pandemic. Figure 2: Change in average mobility of people in transit by continent shows the development of mobility in the continents since the start of the pandemic. The vertical lines represent the time when the first measures have been put in place by most of the countries in that region. Since March 2020, the mobility demand has been significantly below the baseline scenario representing the mobility demand before the pandemic.

If more people permanently work from home, the reduction in commutes would likely produce a long-term decrease in number of trips.

![Figure 2: Change in average mobility of people in transit by continent (Corpus-Mendoza, Ruiz-Segoviano, Rodríguez-Contreras, Yañez-Dávila, & Hernández-Granados, 2020)](image)

According to the reduced mobility also the environmental effects such as the emissions decreased during COVID-19 and especially during the lockdown. The Figure 3 displays the NO₂, O₃ and PM 2.5 concentrations in urban and rural areas in Great Britain, Netherlands, Germany, Spain, France and Italy (Menut, et al.,
The trends of emissions when the pandemic outbreak started is very similar to changes in mobility demand as displayed in Figure 3.

Figure 3: Time-series of daily percentage of reduction (CVD-REF) calculated for each country (urban and rural areas) and three pollutants: PM2.5, NO2 and O3. Results are presented for the whole month of March 2020 and for Great Britain, Netherlands, Germany, Spain, France and Italy (Menut, et al., 2020)
2.1.2 Increased demand for last mile logistics due to e-commerce

Restrictions, recommendations, as well as the risk of infections prevent people from spending time in physical shops. Likewise, people spend more time at home and online. The following graphic shows the results of a survey conducted on 10,000 respondents worldwide about their changes in using e-commerce since the COVID-19 outbreak.

![E-Commerce purchase frequency change due to the COVID-19 outbreak](image)

Figure 4: E-Commerce purchase frequency change due to the COVID-19 outbreak (Pantelimon, Georgescu, & Posedaru, 2020)

The pandemic allowed e-commerce to expand in a more rapid manner. New companies were able to establish, logistics have increased their capacity (sometimes to its limits), new markets were opened (the reach to new consumer segments due to the growth of digital literacy) and new products were added (OECD, 2020).

Especially in Asia the use of e-commerce increased. But also, in Europe the traffic on e-commerce increased compared to the time before the COVID-19-outbreak. Even though the global e-commerce market increased significantly, this growth is limited to some sectors. The following graphic shows the relative difference of the global online traffic by industry in April 2020 and before the pandemic by analysing more than 1400 websites. The sectors benefitting the most are supermarkets, telecommunications, and home furnishing (DIY) (Pantelimon, Georgescu, & Posedaru, 2020).
Increasing e-commerce, especially of fresh goods (e.g. dairy products), increases the road traffic in densely populated urban areas and makes an efficient last mile logistics in urban areas more relevant. Also on a long-term the current pandemic might have an impact on user behaviour and urban planning when it comes to retailers.

"Retail in city centres is changing. Not only due to an increasing pedestrianisation, changes in lifestyle and consumer behaviour, but also due to changing focuses of retailers and effects on real estate in our inner cities. We need to reinvent our cities to make sure that we can still capture the added values of city centres locally."

Ivo Cré, Director Policy & Projects, POLIS

2.1.3 User Behaviour

Based on evidence from European cities, shared mobility and public transport lost relevance since the pandemic began. This is reflecting the shift in reasons to select a mode of transport. Whilst before COVID-19 the key reason to select a mode of transport for business or private trips was the time to destination, since the start of the pandemic the key reason is the risk of infection (see Figure 6) (McKinsey Center for Future Mobility, 2020). This results in a shift from public modes of transport towards private modes such as cycling, walking and private cars.
A survey with more than 8,000 participants identified the perceived health safety of different modes of mobility. According to the survey, with a big head start, the safest modes are private vehicles, walking and biking. Figure 7 also shows that less than 10% of the respondents believe carsharing, ridesharing or shared micro-mobility are safe modes of transport during a pandemic.

2.1.4 Transition to private cars

The mobility systems before the COVID-19 crisis in most of the cities who participated in our survey focused on private cars. In average the modal split of private cars was around 38% – with a significant variation from 6 to 60% due to their diversity on geography, size and urban mobility system (see Figure 8).
Moreover, due to the crisis the modal split shifted towards individual modes of transport such as car, walking and cycling. On a long-term perspective 70 % of mobility users in the United States, United Kingdom, Germany, France, Italy, Japan, and China said in a survey that they would choose to walk or bike at least weekly even after returning to normal life. This is an increase of six percentage points. Likewise, the survey indicates an increase of car usage by one percentage point (McKinsey Future Mobility Lab, 2020).

2.1.5 Reduced use of public transport

Mobility is a good proxy for social interactions, thus the need for social distancing takes a heavy toll on how much people move. Public transport ridership figures plummeted during the pandemic first wave, with reductions ranging 60 to 90 % of the pre-pandemic baseline levels that then stabilized around 30 to 40 % of reductions (see Figure 9). This relates to the survey mentioned in Figure 7 which indicates that only 7 % of the people perceive public transport as a safe mode of transport. One reason behind this is that governments specifically recommend people to avoid any unnecessary travel, targeting public transit with special intensity. Moreover, it is unquestioned that there are disadvantages of public travel compared to individual mobility options in regard to the risk of infection, i.e. exposure time, riders’ behaviour, occupancy levels and ventilation conditions. A detailed discussion on "economic" effects of this can be found in the 5 chapter.

According to the Boston Consulting Group (BCG, 2020), the survey respondents in Europe, United Stated and China report being less likely to buy a transit pass. A reflection of their uncertainty about the total number of trips they would take in each month and the mode of transportation they would choose.
According to a survey conducted in Spain, public transportation was considered as the space with the highest risk for contagion with 31% of the surveyed affirming that (compared and ahead of sport activities in closed spaces and cultural events) (El Pais, 2020). Similarly, a UK survey showed that three out of five people would not feel comfortable using public transport after the lockdown unless specific measures were to be implemented (Intelligent Transport, 2020).

2.1.6 Decreased use of shared mobility

For shared mobility, user reactions on COVID-19 differ quite widely – some systems in some regions are seeing a temporary spike in demand as people shift out of public transit, others are suspending or eliminating offerings as the demand decreased significantly.

On a global level the demand of shared mobility services decreased by up to 70 % (movmi, 2020). Decreasing demand and decreasing investments (see section 2.1.7) in the sector of shared mobility, might lead to the consolidation of the market. This will likely favour success (and survival) of larger players with higher cash reserves.

Differentiating between different options of shared mobility, there are two main trends visible (Corwin, Zarif, Berdichevskiy, & Pankrat, 2020):
1. Bike and scooter sharing systems are sustaining (or increasing) their number of users in cities, where governments pursue new infrastructure conducive to bikes and e-scooters.
2. Ride-hailing companies continue to shift their business model into good delivery.

2.1.7 Reduced Investments in strategic research and development

As the pandemic is not only a health but also an economic crisis, investment in innovation and future mobility has been decreasing. Amongst others, this can be seen in the decreasing jobs and postponed innovation projects at big car manufacturers (Keown, 2020). The focus of many companies active in the field of urban mobility currently is day-to-day management of the crisis as a decreasing mobility demands also result in decreasing revenues.

Opposing the decreasing investments of the automotive industry, 46 % of the cities that conducted the survey indicated that the pandemic did not have any effects on their mobility strategy and on the projects planned. According to this result it is possible to understand that some of the cities, despite the health crisis were able to pursue their objectives. It can be assumed as one of the causes the long-term planning and the fact that some of the plans were already being implemented, making it worse to stop rather than to continue them. Also, most of the plans have particularities that support the health safety on urban mobility, thus, meeting the city needs.

**Figure 10: Survey result from the question: How has COVID-19 impacted the city’s mobility plans?**

Thus, the COVID-19 crisis could delay the development of advanced technologies, such as autonomous driving (Keown, 2020). Also ride hailing companies have experienced declines of up to 60 to 70 percent, and many micro mobility and carpooling players have suspended their services (McKinsey Center for Future Mobility, 2020). As the public investment in micro mobility and shared-mobility providers might drop, the consolidation of the market might be accelerated. This will likely favour success (and survival) larger players
with higher cash reserves. On the other hand, 75% of the cities taking the survey are supporting multimodal ticketing which supports micro mobility options and favours an up-take of this segment after the pandemic. Therefore, such actions promote the cities’ transport multimodality, making inhabitants having easy access to more mobility options and not only private cars and public transport. As a consequence, supporting sustainable mobility and not saturating the classic modes of transport.

<table>
<thead>
<tr>
<th>%</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offer Multimodal Ticketing</td>
<td>25</td>
<td>75</td>
</tr>
</tbody>
</table>

Yes, BUT it’s only a SHORT TERM measure (will conclude after the pandemic)

Yes, and will be maintained after the pandemic since it was PART OF OUR MOBILITY PLANS

Yes, AND will be maintained after the pandemic THOUGH it was NOT part of our mobility plans.

**Figure 11:** Survey Results from the Question: *Do you offer multi-modal ticketing due to COVID-19?*

“In city administrations there has been a redeployment of strategic personnel into other urgent tasks to tackle the pandemic, as well as challenges with home-working and increased sick leave. There is a lot of willingness to do more, however it is challenging for cities to allocate resources, especially for strategic issues.”

---

Dr. Anna Clark, Innovation Lifecycle Manager, EIT Urban Mobility Innovation Hub North


2.2 Public Sector Measures

This section shows how cities have dealt with mobility during the pandemic and what measures might be applied in the future. Some trends and examples are also presented.

2.2.1 Increasing Public and Shared Transport Safety and Trust

2.2.1.1 Public transport

Since the beginning of the pandemic, cities have progressively taken measures to slow the spread of the virus in public transport. These are among those measures that were taken the earliest when the pandemic started. As seen in the previous section, strict lockdowns reduced the capacity of people to move around in the city but the loosening of those and the possibility of moving more freely again was accompanied by a fear to use public transport modes.

So far, there seems to be certain consensus that the risk of infection in public transit use is related to the exposure time (travel time), riders’ behaviour and use of self-protection measures (silence and masks), crowding and ventilation conditions. According to several studies conducted in Germany, France, the UK, the US, and Japan the risk of contracting COVID-19 while travelling by public transport is between 0 % to 1.2% (variances depending on calculation methods and sample) (UITP, 2020).

To respond to the concerns of passengers as well as to guarantee no further spread of the virus in public transport vehicles, cities and transport authorities have implemented several issues. Some of these include:

- Establishing new protocols for frequent and comprehensive cleaning of transit vehicles and facilities,
- Promoting or requiring the use of face masks inside public transport,
- Automating doors to prevent passengers from pressing buttons,
- Limiting vehicle capacity,
- Providing hand sanitisers in the vehicles,
- Increasing the ventilation and air renewal in the vehicles,
- Coordinating with big employers to encourage time flexibility (or establishing home office quotas) in order to flatten the demand curve in peak hours
- Increasing the frequency of services during busier periods
- Enabling physical distancing at stations and stops
- Encouraging contact less payments (and sometimes prohibiting other forms)

In the survey conducted for this study, a majority of the cities established protocols for comprehensive cleaning of public transport vehicles (69 %), made mandatory the use of masks (87 %), and increased the communication about hygiene of public mobility (73 %). Interestingly, 23 % of these cities were planning to maintain cleaning protocols after the pandemic versus 46 % which were considering a short-term measure. Similarly, 21 % of the respondents mentioned that they will continue with the communication activities about public transport hygiene, while 53 % will not after the pandemic. Although these numbers only give a sense of which measures may be prolonged in the future, there are further challenges that will need to be addressed when looking towards the end of the pandemic and the return to a normal time.
There is the need to make public transport attractive again. New solutions with flexible ticketing and digitalization of services will play a major role. Also, it is key to communicate that public transport it is safe for the citizens.”

Sandra Lima, Project Officer, European Passenger Federation

2.2.1.2 Shared mobility

With the shrinkage in mobility (see section 0), shared mobility services and providers of e-scooters, bicycles, mopeds, and cars have been hit by the crisis. Most people did not believe that carsharing, ridesharing, and shared micro-mobility (bikes, e-scooters and mopeds) were a safe option to travel during the pandemic. This poses serious challenges to cities and service providers who want to increase the share of this mode of transport in the mobility mix.

During the initial months of the pandemic and subsequent lockdown, several cities took measures in this regard. For example, the UK moved forward in June 2020 with a framework to enable the deployment and testing of e-scooters in English cities. The regulation was planned for 2021 but was prioritised to boost the green recovery from the pandemic and to help mitigate the impacts of the ongoing climate crisis (Mehmet, 2020). The trials started in a few cities and it is planned a second wave of trial cities, which can demonstrate the value and role of e-scooter in urban mobility. In an effort to ease the uptake of shared mobility, Madrid announced in June 2020 the deployment of 5,000 new electric bikes to support the existing bike sharing scheme (POLIS, 2020). Similarly, Glasgow and Edinburgh offered temporary free access to bike-share services for the first 30-minutes of every journey. The measure aligned with their Phase 2 COVID-19 route map, where indoor non-office workplaces and street-access retail resumed their activities (Intelligent Transport, 2020).

Another phenomenon was the repurpose of shared vehicles for new tasks. For instance, Voi (e-scooters service provider) teamed up with the platform Gigstr (professionals network to find gigs and talents) in Stockholm and Gothenburg to offer a safe and for free option for mobility (Voi Technology, 2020).

1 The UK has lagged behind many European cities in this area, since it was not possible by law to implement e-scooters.
“The two big European E-Scooter companies Tier and VOI confirm that now, they are above the break-even point in their daily business for the last months of 2020. In the beginning of COVID-19 they struggled but like many other markets they adjusted their strategies and found a way through.”

Peter Vest, Business Creation Manager, EIT Urban Mobility Innovation Hub North

2.2.1.3 Towards the future

Although recent studies have shown lower chances of contagion in public transport (when face covering, ventilation, and disinfection is assured and contact is for short time), transport authorities are dealing with what the International Association of Public Transport has called an ‘unjustified stigmatisation of public transport’ (UITP, 2020). This association, which brings together more than 1,800 public transport companies from all around the globe, has made a call to action to regain passengers’ trust. Transport authorities and local authorities do not only need to guarantee people that using public transport is safe during COVID-19-times but also make this option attractive considering the latest shifts in mobility (higher presence of private cars – section 2.1.4). Moreover, to achieve sustainability and climate objectives, cities and city-regions will have to examine other expected and unexpected consequences that the pandemic might leave, such as the potential move of certain population groups to the suburbs.

“Public transportation is the only mode that is heavily affected after all these months. The main mobility challenge after COVID-19 will be to get people back into public transportation.”

Peter Vest, Business Creation Manager, EIT Urban Mobility Innovation Hub North

If no active measures are taken to get people back to using public and active modes of transport after the pandemic, cities will move from a lockdown to a gridlock. And those measures will need to particularly address the mistrust or fear of people and other mobility-related behaviours developed during the pandemic.

With regards to shared mobility, McKinsey suggests a greater uptake of shared mobility and electric vehicles postcrisis in Europe (McKinsey Center for Future Mobility, 2020). Along the same lines, an analysis done by the Directorate-General for Internal Policies from the European Commission, stated that ‘given the public transport’s need to reorganise itself more flexibly [especially after the pandemic], shared vehicles, such as electric cars, bicycles, e-scooters, can become part of the public transport offer. This integration can be organised through new forms of PPPs, providing privileges and subsidies for the operators who adhere to the scheme and in exchange share selected data with the public authorities, useful for planning and monitoring the transport system’ (Lozzi, Marcucci, Gatta, & Pacelli, 2020).
2.2.2 Rethinking streets: Pedestrianisation

During the current pandemic, public life and with it, the public spaces where it takes place have been altered. A major factor of this transformation was and, still is, the need for more space between people; in other words, space for social distancing that can prevent the further spread of the virus among people. Depending on the phase of the pandemic and the type of measures governments have taken in European countries, public spaces are seeing varied levels of occupation: from very low levels when lockdown and isolation measures are very strict to higher levels when those measures are being relaxed. It is in this transition towards recovery that public space will play a key role in making sure that streets offer a safe space for people to socialise, shop, and access essential services.

One of the shifts seen during the pandemic was the increase of pedestrian areas with the goal of providing people with more space to comply with physical distancing rules while walking or waiting, but also to promote walking as a mean of transport. Taking away space dedicated to motorised traffic or parking has also been done to increase outdoor spaces for shops and restaurants, as well as open markets.

2.2.2.1 Temporality

In some cities, like Vienna, the pedestrianisation of certain areas has been communicated as a temporary measure (COVID Mobility Works, 2020). In some other cities, like Barcelona and Milan, the disruption in urban mobility patterns has been taken as an opportunity to move forward with existing pedestrianisation goals. For instance, 53% of the cities participating in our survey extended sidewalks or pedestrianised some of their streets, the measure will be maintained after the pandemic since it was part of the city’s mobility plans. Worth mentioning is that 47% respondents did not introduce such changes in their cities, meaning that although there is a growing presence of more pedestrianised areas or extended sidewalks in several cities, not all cities have taken this measure during the pandemic, opening the question on what challenges, strategies and decisions have been made in those cities that may have either prevented or directed towards different procedures and projects.

2.2.2.2 Transforming walking

Pedestrian areas have not only changed by being expanded in some cities, but also local governments and transport authorities have taken measures that affect how people move in these areas. For instance, in order to reduce the time that people spend waiting for pedestrian crossings to turn green, Dublin has reduced the maximum amount of time people can wait for pedestrian crossings to turn green from 120 seconds to 80 seconds throughout the city (Dublin City Council, 2020). Brussels has followed a similar approach to improve road safety and smoothness for all road users, by shortening light cycles and automating cross signals in as many intersections as possible. According to Brussels Minister for Mobility, ‘Cyclists and walkers now have longer and more frequent green, so that no traffic jams occur at intersections’ (Bruxelles Mobilité, 2020).

Similarly, cities like Cardiff or Amsterdam, have transformed streets in the city centre and shopping areas into one-way streets to ensure social distancing is observed. For that purpose, they have marked the routes
with different type of signals to make sure people follow the directions (COVID Mobility Works, 2020) (Cardiff City Council, 2020).

2.2.2.3 Towards the future

It is quite possible that the new pedestrianised areas remain after the pandemic. Whether they have been in the planning log of the cities or not, encouraging more active modes of transport is a common goal across Europe (Euro Cities, 2020). The presence of these measures over a long period of time (close to a year since the beginning of most COVID-19-related mobility practices) may prove to be a success for transforming mobility behaviours. Worth noting is that this will be challenged once there is return to normality.

“At the beginning of the pandemic, people were just waiting for it to go away and quickly return to the normal. But once it was clear that it was not going back to what it used to be, people started to look towards the future. Thus, the window of opportunity is more open than ever. Politicians should not only be worried about the pandemic but also about how to change their cities for the future.”

Peter Vest, Business Creation Manager, EIT Urban Mobility Innovation Hub North

2.2.3 Making cycling more attractive through infrastructure developments

A measure that many cities have taken during the pandemic and which has been particularly emphasised in the media are the extension or creation of new bike lanes, in many cases taking space away from motor vehicles and giving it to bicycles. Not only incentivising the use of bicycles complied with many mobility strategies but also, it proved to be a noticeably safe way to travel during the pandemic.

Some of the cities that have implemented new bike infrastructure during COVID-19 times include, Berlin (27 kilometres of pop-up lanes), London (30 kilometres of permanent lanes), Brussels (40 kilometres of provisional lanes), Madrid (12 kilometres of provisional lanes) (El Pais, 2020).

“We are seeing two important trends in cities: a positive and a negative one. The first is that there has been an increase in active mobility. The second is that there has also been an increase in private mobility and car sales (second hand cars, especially, which pollute more).”

Daniel Serra, Innovation Hub South Director, EIT Urban Mobility

2 The Mayor of London has also promised to multiply the city’s cycling infrastructure by 10 times by 2025.
Some cities have been improving their cycleway infrastructure for years, and the pandemic has helped to accelerate those plans. However, in the survey conducted for this study, it was found a discrepancy in the answers referring to measures taken to promote the use of bicycles in the cities. The vast majority of the cities did not implement measures as “Build pop-up bike lanes”, “Classify bike shops as essential services” and “Offer free or reduced price bike or e-scooters shared access” over the last months. These cities did not seize the opportunity to expand them and only one announced that these provisional measures will soon become permanent. However, the majority implemented regulations to support active modes of transport as cycling and walking.

Provisional infrastructure like pop-up bike lanes is a good emergency strategy. Our survey results show that cities need to go further. Measures which will be maintained after the pandemic but were not part of the mobility plans already is almost non existing. Changes in mobility behaviour need good administrative support and pop-up cycleways need to be transferred to a sustained solution. Otherwise, as soon as traffic returns, the use of bicycles may fall again.

Furthermore, there are distinctive challenges and requirements connected to the promotion of bike use in cities. In our survey, inefficient or inexistence bike lanes were mentioned by more than one quarter of the cities as one of their main mobility challenges before COVID-19. The quality of the cycling infrastructure varies widely from city to city – even those that have substantial efforts during the outbreak to extend them. It ranges from wide, well-connected lanes to lanes which end abruptly in the middle of a traffic intersection or weaving in and out of traffic giving cars the privilege. Others have serious shortcomings as they are just markings on the road that do not segregate cyclists from other forms of transport (including pedestrians), narrow cycling lanes, dirt on the lanes, or cars parked in the lanes (El Pais, 2020). These examples help to understand that evaluating a bicycle network is much more than only considering the length. For instance, the quality of the lanes has to be ensured – including connectivity between lanes and other ways, separation from other means of transport, pavement quality, etc – and that requires a good understanding of the needs of existing and potential cyclists.

A potential cause for the challenges in expanding cycling infrastructure across cities may stem from the lack of information about real-time (or near) usage of bikes lanes and bike journeys, which makes difficult to assess whether their existing networks are effective or if there is a need to expand the network with long-term or pop-up lanes. However, some cities have been successful to use date to better plan their emergency policies and measures. Those are described in Section 2.2.6.

Finally, the effectiveness of these measures will also depend on how inclusive they are. Although there is very little data about this issue in the current context at the moment, there is some that can pinpoint fundamental matters. For example, “in June, the City of Toronto approved 40 kilometres of new bike lanes: the largest one-year increase in the city’s history. Of the eight projects, five were in the gentrified urban core (including two directly above a subway line). None can be found in neighbourhoods with the highest rates of COVID-19 infections” (Doucet & Mazumder, 2020). And though this may not be the case in all cities, it can only be understood to address this problem by measuring it and designing policies that do not neglect it.
2.2.3.1 Towards the future

Undoubtedly, the pandemic and its lockdown has served as an opportunity for many cities to implement certain changes (e.g. new bike lanes) that would have been otherwise resisted by certain groups (e.g. car drivers) of the population in normal times. However, this move does not represent all cities as it was observed in the results of the survey conducted for this study. The reasons why the latter has happened may be found in the reduced availability of resources (budget and staff) because of the pandemic, as well as political support in a time where COVID-19 was the main agenda.

Nevertheless, the opportunity to introduce these changes in cities is not yet lost. Cities will have to still navigate through uncertainties in the aftermath of the crisis and definition of the new normal.

2.2.4 Addressing air pollution from mobility sources

A common policy used in several European cities to reduce air pollution, greenhouse gas emissions and congestion is the introduction of Low Emissions Zones (LEZ) or Clean Air Zones, where the most polluting diesel vehicles are banned from entering an area³. More ambitious attempts may be called Ultra-Low Emissions Zones or Zero Emissions Zones. Last year, 34 cities across the world signed the C40 Green and Healthy Street Declaration where they pledged to ‘ensure a major area of the city is zero emission by 2030’ (C40 Cities Climate Leadership Group, 2019). Recent studies have shown that air pollution causes seven million premature deaths every year, increasing the risk of diseases of the respiratory system (WHO, 2020). This is especially relevant in the current pandemic, where authorities have alerted about the increase of vulnerability of people who are exposed to air pollution and to COVID-19 (WHO, 2020).

Although in the past two years several cities have committed and even started to implement LEZs, the current pandemic has made some of them to put these plans on hold or delay them. For instance, Birmingham had approved and was planning to introduce a Clean Air Zone during the summer of 2020, but it has delayed it until at least – June 2021. Non-compliant vehicles driving in the Zone would have to pay once a day to be able to drive in the area and the Zone will operate 24 hours a day, 365 days a year. The main justification given to put the plans on hold was to be able to monitor the effects of COVID-19 and the acknowledgement that small businesses – which have been hit by the economic effect of the pandemic – would find hard to upgrade their vehicles to electric owns this year (BBC, 2020). Likewise, Barcelona’s LEZ came into force in January 2020 and was supposed to start in April 2020, however, due to the health emergency this was delayed until September 2020. In this case, the Low Emissions Zone applies from Monday to Friday from 7am to 8pm, and non-compliant vehicles cannot circulate at the stated time, having to pay a fine for doing otherwise (Info Barcelona, 2020). Another example from a city-region is Greater Manchester, which also delayed implementation until spring 2022. The goal of their Clean Air Zone is to encourage upgrades to cleaner vehicles, and the Greater Manchester Authority is requesting £150m of government funding to support people and organisations to make the transition. The Authority has also run a public consultation process which will inform their Clean Air Plan (Clean Air Greater Manchester, 2020).

³ Some cities also specify the type of vehicles differentiating heavy duty from light duty.
Nevertheless, there are also examples from cities which have been able to maintain their plans (e.g. Stuttgart) and even expand them (e.g. London). In the first case, Stuttgart moved forward in July 2020 with the already approved measure which stated that owners of diesel vehicles with the Euro 5/V Emissions standard and lower are no longer allowed in the city centre (ADAC, 2020). This measure adds up to the existing diesel ban to Euro 4/IV vehicles in place since January 2019 in the city. In the second case, London announced in August 2020 that its Ultra Low Emissions Zone will be 18 times the size of the current one, which is expected to reduce nitrogen oxide (NOx) emissions from road transport by 30%. To achieve that, they will be installing 750 additional cameras to control the area and offering financial support to switch to cleaner vehicles and modes of transport (Mehmet, 2020).

2.2.4.1 Public opinion on air pollution

With the reduction of economic activity and movement during the initial steps of the lockdown measures in Europe, air pollution also saw a substantial contraction of 25 to 55% in European cities compared to the same time in 2019 (European Environment Agency, 2020). According to a survey conducted during in May 2020 and which covered major cities in France, Germany, Italy, Spain, UK, and Belgium. Interestingly, ‘while 55% of Germans agreed that "effective measures to protect citizens from air pollution" should be introduced "even if it means preventing polluting cars from entering the city," in other countries, where lockdown measures were more extreme, between 74% and 82% of the population supported such policies’ (Posaner, Cokelaere, & Hernández-Morales, 2020).

![Figure 12 - Attitudes towards air pollution (Posaner, Cokelaere, & Hernández-Morales, 2020)](image)

As a broad indicator, road traffic currently makes up around 50% of total NOx emissions for most European cities, although this varies by location and country (Air Quality Consultants, 2020)
2.2.4.2 Towards the future

Although the pandemic forced a halt in the economy and movement of people and thus, air pollution declined substantially for a period of time, cities still have to comply with EU air quality standards during and after the pandemic. Experts have warned about a rebound effect in traffic emissions if the tendency of using more private vehicles remains above pre-pandemic levels (Air Quality Consultants, 2020). Therefore, cities will need to reconsider their mobility strategies, especially those that could disincentivise the use of the car (in the rise during COVID-19) and encourage cleaner and more active modes. Low Emissions Zones will remain a valuable measure to tackle air pollution and congestion in cities, but special consideration will need to be given to how long these measures can be delayed and how much support vulnerable and worse-hit businesses will need to be part of the transition. Furthermore, congestion will need to be addressed in the aftermath of the pandemic, since it is already known the impact it has in productivity and, ultimately, GDP (about 1% in the US, UK, France and Germany) (C40 Cities Climate Leadership Group, 2018). Finally, LEZ and similar measures cannot be designed alone, but they have to be part of a mixture of measures that are able to influence or nudge people to take more active and cleaner modes of transport.

2.2.5 Freight and urban logistics

Due to the pandemic and lockdown measures, there was a steep increase of e-commerce sales which caused an increase of deliveries. A study conducted in Paris, showed that although e-commerce and food deliveries increased in the city (with home deliveries increasing by around 300% in some cases), non-food shops and deliveries for restaurants, hotels, and cafes have all decreased substantially. Experts in the field have mentioned that “purchasing behaviour will be changed permanently, which could have major ramifications for how urban logistics operate” (POLIS, 2020).

Cities have taken some measures concerning urban logistics during the outbreak of COVID-19 that can be grouped into two groups: temporarily relaxing regulations to reduce the pressure on logistics companies and creating supporting mechanisms and actions to ease the adaptation of this sector to new urban landscape. In the first group are included cities like Zaragoza - which extended the loading and unloading hours at essential businesses and services to 24 hours for about 2 months (Ayuntamiento de Zaragoza, 2020) - , London - which delayed the enforcement of the new minimum standards for emissions for the most polluting heavy diesel vehicles for four months (Transport for London, 2020) - , or Lisbon – which enabled bike sharing services to those delivering food and medication for free (prohibited before) and connecting ride-hailing and taxi companies with local businesses to offer food deliveries during the state of emergency (Camara Municipal de Lisboa, 2020). In the second group are considered initiatives like the one from Paris where a map with all planned changes such as new cycle lanes, pedestrian zones or street closures have been made public and delivery vehicles are permitted to enter pedestrian areas. Furthermore, a shared electric-vehicle service for commercial operators is being rolled out to enable zero-emission deliveries for businesses and microhubs, off-peak and night deliveries are being trialled (POLIS, 2020).
2.2.5.1 Towards the future

The expansion of pedestrian and bike lanes, as well as the introduction of Low Emissions Zones will affect urban logistics in the short and long-term. This and changing consumer patterns will need to be considered when planning sustainable urban logistics in cities. Here a special role will be played by intelligent and more efficient design of delivery routes and clean, sustainable, and comprehensive last-mile delivery solutions.

2.2.6 Using data to accelerate and improve decision-making

Digital tools and data have played a fundamental role in the current pandemic, from enabling people to do many of their jobs from home to maintaining daily updated figures of cases globally. Similarly, in the field of mobility, data has been used to inform decisions and measures that could encourage certain mobility behaviours. Moreover, mobility data has been a useful resource to provide insights into virus spread and containment (Zachreson, et al., 2020) (Barcelona Supercomputing Center, 2020).

2.2.6.1 Planning according to actual mobility patterns

Utilising data provided by 14 mobile network operators in 19 EU Member States and Norway, a study from the European Commission’s Joint Research Centre analysed mobility patterns and compared against geographic areas. They introduced the concept of data-driven Mobility Functional Areas (MFA) as ‘geographic zones with high degree of intra-mobility exchanges’ (Iacus, et al., 2020). MFA make a substantial contribution to cross-regional and provincial mobility planning. In the EU, there are several cases where people must cross national or international borders to reach a grocery shop or go to work, however, many decisions are still made within political borders. This could be observed in the study where the comparison between pre- and post-lockdown mobility patterns demonstrated a shrinkage of the latter with groups of people seeing their mobility patterns in their usual MFA restricted (Iacus, et al., 2020).

Another example can be found in the city of Thessaloniki, which counts with a Smart Mobility Lab run by the Hellenic Institute of Transport. The Lab cooperates with the City Council to address mobility challenges and inform decision-making through a data-driven approach. At the outbreak of COVID-19, the city worked together with the lab to determine how to decide which roads to select for implementing bike lanes. For that purpose, they tracked driving behaviours of users of free-floating bicycles, which helped to then select locations for temporary bike lanes in the city. Already having access to this data and being able to analyse it, made the decision making process faster and more accurate, especially considering that there was an increase of 36% of shared bike use in some areas of the cities (Momentum, 2020).

Another case to look at is the city of Funchal, which has been a testbed for the implementation of several innovative measures, such as automatic traffic counters and environmental stations. These devices are used to collect and analyse data to further understand the mobility patterns in the city as well as to support decision making process and evaluate the impact of certain actions. During the COVID-19 confinement period, for instance, these devices were useful to monitor traffic. Similarly, Rome has also used data to re-orient local public transport services to current user needs.
2.2.6.2 Informing and nudging transport users real-time

An important action towards reducing potential exposure in public transport has been the control and management of the occupancy levels in public transport vehicles. Data is an important tool here for planning and implementing changes real-time, enabling more flexible measures (compared with more static ones if they are decided once and applied homogeneously). For instance, the Government of Catalonia launched a new functionality in its existing bus app which informed users about the level of occupancy of a bus for a specific route and planned time. With this, they wanted to enable citizens to choose other options when bus occupancy is high (Autocorb, 2020). Similarly, the regional transport association RMV in Germany, implemented a new software able to forecast occupancy which users can access via their mobile website. Their goal is to ‘restore passenger confidence in public transport’ (Mehmet, RMV introduces passenger forecast software in Frankfurt, 2020). Another example is given by Aachen which is planning an incentive app for using climate-friendly transport. Through the app users can earn points which can be redeemed in local stores (CIVITAS, 2020).

2.2.6.3 Citizen Participation for Mobility Measures

In order to act quickly and be able to introduce temporary measures to make streets safe for walking, cycling, and wheeling, and ultimately avoid unnecessary car journey, Edinburgh’s City Council created a platform where citizens can send suggestions to the Council for temporary measures they would like to see (City of Edinburgh Council, 2020).

2.2.6.4 Towards the future

Besides the examples mentioned here, there are many other cities in Europe who have harnessed data to improve decision making in a time of uncertainties and required speed. Although there is an acknowledgement of the role of data and its potential to improve decision making, challenges for its further use remain. These challenges and aspects around organising data management and analytics will be discussed in Section 4.12.

2.2.7 Being responsive to the needs of vulnerable groups

During normal times, there exist plentiful barriers that people with disabilities face when moving in a city. The pandemic and the subsequent lockdowns or restrictions affected existing mobility patterns and choices. For instance, measures like restricting access in certain doors (front-doors in buses) possess challenges to disabled certain groups that need to access through that specific door or if a person needs assistance from the driver for boarding the vehicle, maintaining a safe distance might not be possible (Schweiger, 2020).

Likewise, lockdown and mobility measures have affected differently diverse income groups. A study in Spain showed that there were pre-existent inequalities in the distances people from different income segments have to move to go to work (since most essential workers belong to low-income segments). It also found that ‘the population with the lowest salaries expend in average a 47 % more in their daily displacements (in cost and time) that the population with the highest salaries’ (Hernando, Mateo, Barrios,
A mobility guide recently published by ICLEI also asserts that ‘those who were already facing difficulties in accessing transport have done even more so during the COVID-19 pandemic, with people who rely on public transport hit hard by service cuts and reduced capacity. Women especially, as the lack of authorisation to carry out their daily activities strongly impacted their ability to earn’ (Drăguțescu, 2020, p. 6).

Along the same lines, Public Health Scotland (national health board of the NHS in Scotland) has highlighted in a Policy briefing that ‘reduced capacity and use of public transport are likely to reduce transport options and add financial strain for people without access to a car, people on low incomes, older people, disabled people, people with health problems and younger people’ (Teuton, et al., 2020, p. 2). Considering that there has been an increase in private transport across many cities in Europe, the Scottish board highlighted that children and adults in low-income communities ‘experience higher levels of injury from collisions on the road and are at increased risk of exposure to air and noise pollution’ (Teuton, et al., 2020, p. 4).

Although this may be among the most overlooked challenges, there are good examples from cities who have managed to take into account vulnerable groups when implementing mobility measures during the pandemic. For example, ‘Madrid’s mobility operator EMT has made efforts to extend its collaboration with Passengers with Reduced Mobility stakeholder bodies to a specific campaign, launched post-lockdown, focusing on helping those passengers most in need to have access and comfort when travelling on buses. Their main message was ‘Don’t leave anyone behind’, encouraging ‘passengers to assist vulnerable groups by helping them to their seats, keeping a safe physical distance and respecting priority seating’ (Peters, H. et al., 2020, p. 16). Recently, the UK government has put three proposals to consultations that aim to improve accessibility of sidewalks for visually impaired, elderly, and mobility-impaired people. The government’s goal is to make legal conditions tighter to reduce pavement parking. The consultation includes three specific proposals: ‘improving legal setting for councils to prohibit pavement parking in their areas, giving councils powers to fine drivers who park on paths, and a nationwide blanket ban on pavement parking’ (as it exists today in London only) (Köllinger, 2020).

2.2.7.1 Towards the future

Although the pandemic might have surprised many authorities and demand rapid actions, considerations about further impacts on vulnerable populations should not be left behind in the immediacy of taking action. Some of the main steps public and transport authorities could follow to respect people with disabilities rights include: ensuring the response to COVID-19 is compliant with the UN Convention on the Rights of Persons with Disabilities, involving persons with disabilities in the COVID-19 response and recovery, ensuring marginalised and isolated people are not left without human contact, essential goods, or support, etc (European Disability Forum, 2020).
2.3 **Trends adopted by industrial players**

2.3.1 **In-vehicle tech-solutions to ensure a true public health agent**

As described earlier, the outbreak and global spread of COVID-19 has significant impact on the mobility behaviour of people. As cases of the virus soar worldwide, in particular companies in the so-called gig-economy, e.g. shared mobility (which covers ride-hailing and carsharing) but also delivery companies, have come under increasing pressure to look after people who work on their platforms and are typically classified as independent contractors, often lacking sick leave and other benefits. Many shared-mobility service providers worldwide had to suspend their services, lay off staff and have taken various measures in order to protect drivers, passengers and their businesses (MOVMI, 2020). With regard to the pathogens’ ability to travel, buses, trains are of course excellent ways of spreading of infections – the study (Luo, Zhao, & Hai, 2020) highlighted the transmission of COVID-19 in crowded and closed settings; however, the majority of secondary cases were keeping social distance.

In order to ensure a systematically coordinated response and effective implementation of measures by public transport companies, fleet operators and shared mobility operators, contagious virus or pandemic response plans shall form the basis for action and measure implementation. In that sense, the industry (Phelan, 2020) has explored several domains to help lessen the risk of infection and spread virus in urban transportation vehicles.

### 2.3.1.1 Cabin disinfection

Ultraviolet (UV) lights in the car cabin can be used to disinfect several frequent-touch surfaces. However, UV light is a component of the natural sunlight, to which people are daily exposed to. Furthermore, its shorter wavelength UV causes alterations in the molecular structures and their genetic material, but normally screened out by the Earth’s atmosphere.

That is why it is important to reduce the human exposure to ultraviolet light. Grenlite (Anguita, 2020) powered by the Spanish company GSHP, is an intelligent solution which activates the UV lights when no one remains inside the vehicle.
The ozone-generating technique has a clear advantage over using concentrated UV light to disinfect surfaces: Ozone technology is gaseous, so it can reach crevices and cracks and migrate freely throughout a vehicle cabin versus the line-of-sight that’s needed for sanitizing with UV light. Magna (Buchholz, 2020) has explored a sanitizing cycle which generates a high ozone concentration by energizing the oxygen particles on the items inside cabin. This technique could contribute to gain customer trust of ride sharing and public transport services.

2.3.1.2 Cabin air purification

Car manufacturers can install plasma air purifiers that can filter air impurities down to PM2.5, which is considered adequate to combat germs and pollution. In-car plasma air purifiers are something relatively common in several Asian countries, which means the technology is ready for adoption. Use of high-efficiency particulate air (HEPA) filters can also filter germ airborne particles in the cabin when climate control is set for air recirculation making it safer for passengers. Tesla introduced the “Bioweapon Defense Mode” in Model X, which uses a HEPA air filter system that removes most pollutants, bacteria, and viruses, the company claims (Torchinsky, 2020).

2.3.1.3 Air filtration

Disinfection can also be done improving heating and air conditioning systems, where the car’s climate control can heat up the cabin for a long period to reduce the amount of microbial contamination. Chinese automaker Geely Motors is installing “G-Clean Intelligent Air Purification System (IAPS)” system in all its production vehicles claiming filter efficiency similar to an N95 respiration system (Geely Auto, 2020).

2.3.1.4 Connected car functionalities

Automated door locks and engine start/stop actions via mobile applications can reduce surface contact inside the vehicle. Mobile applications can be used for car sales and after-sale contactless services, such as test drive, dealership vehicle servicing, roadside assistance, home maintenance service and vehicle home delivery.

2.3.1.5 HMI

The use of an effective voice assistant can reduce contact with cabin surfaces. The adoption of Artificial Intelligence (AI) technologies can make the interaction between passengers and the vehicle more personalized and at the same time help in early detection of symptoms. For example, emotion AI could detect visible symptoms in passengers such as cough and fever and notify the driver.

2.3.1.6 Antimicrobial materials

The existing plastic and glass surfaces in the car can also be replaced by antimicrobial plastics, leather and glass that resist viruses, bacteria, mold and fungus, reducing the possibility of contagion from drivers and passengers touching cabin surfaces. However, antimicrobial treatments don’t necessarily remain effective as long as most vehicles stay in use. Most antimicrobial material technologies are additives or coatings which contain metals known to be biocidal. For example, copper and silver are natural antimicrobial materials that have intrinsic
properties to destroy a wide range of microorganisms. Some natural polymers, such as chitosan, heparin, and e-polylysine can also inhibit the growth of disease-causing microorganisms (Oro, 2020). Research shows that graphene also offers opportunities as new antimicrobial material. Another way of creating antimicrobial properties is by embedding nano-structures in fabrics and other surfaces that inhibit microbes from living and breeding on the surface.

2.3.2  Foresight: medium-term effects of the pandemic

According to CBINSIGHTS, the response of industrial mobility players to mitigate COVID-19’s impact encompasses four stages (crisis, adjustment, recovery and vision) up to 5 years from now, which results in new emerging trends.

![Figure 14 - Future landscape and medium terms effects of the pandemic in the mobility industry.](image)

2.3.2.1  Emerging trends during the adjustment stage-today

As presented above, due to consumer preferences changing rapidly, industrial players have explored new connected car software for micromobility providers (Superpedestrian), subscription-based offerings to enhance stickiness (Lime), self-chaining handlebars and brake levers on bikes (NanoSeptic). Traditional auto retailers have been slow to adopt digital car-buying solutions, but with lockdowns closing dealership doors, the pandemic largely accelerated the shift to omnichannel auto retail with entry of new actors. This is the case of the startups AutoFi (financing solution that convert leads to online customers), Digitalmotors (car-buying platform), Modal (online buying process), Roadster (explore and compare inventoried vehicles) and Carvana, which revolutionized the car-buying experience providing virtual tours for vehicles. The growth of ecommerce resulting on new challenges for delivery services – Autofleet, in collaboration with Avis Budget Group, Zipcar and Suzuki have developed a fleet optimization software that allows fleet operators to repurpose idle vehicles for applications in high demand.
2.3.2.2 Emerging trends during the recovery stage – one year from now

Major transportation players are re-prioritizing as they recover post-pandemic. Electrification is emerging as the main focus for the automotive giants, utilities (Iberdrola, Engine, EDF) and oil majors (BP, Shell, Chevron). Self-driving technology requires significant investment and more feasible applications such as active safety solutions of Aptiv – joint venture with Hyundai, improve ADAS (Advanced Driver Assistance System) systems through a perception stack combined with lidar (VOLVO-LUMINAR) and automated driving functions from NVIDIA-Mercedes Benz. On the delivery front, autonomous “middle mile” delivery has also gained traction in recent months: in the US, Gatik partnered with Walmart to improve the delivery services during pandemic, Navya and Beep began deploying AVs to transport medical supplies and COVID-19 tests, GM’s self-driving subsidiary Cruise has started deploying its AVs to make deliveries for food banks in San Francisco, Pony.ai launched a driverless delivery service to help fulfil grocery orders during the COVID-19 lockdown.

2.3.2.3 Emerging trends during vision stage – five years from now.

Amazon furthers its effort to build out its own transportation ecosystem through recent investments in Electric Vehicles truck maker Rivian, in autonomous driving technologies of Aurora Innovation, and ZOOX.

Intel/Mobileye is also making notable moves in the mobility space to accelerate its autonomous driving development and create a base for future robotaxis deployment.

Regarding the public-private partnership, the startup VELOCIA launched an open loyalty service for integrated mobility relying in part on decentralized technologies.
2.4 Discussion

With this chapter, it is possible to understand the changes in the requirements and strategic planning of urban mobility systems due to COVID-19. Adding to the long-term challenges, requirements and strategies for sustainable urban mobility (see the 1 Chapter), the short-term impacts of COVID-19 can be taken as an opportunity to foster and accelerate long-term sustainable change.

In a first glimpse, it seems that some cities are not reconsidering their long-term mobility strategies, but on the contrary, using the COVID-19 measures to accelerate some of them:

- The increase of tactical urbanism to temporarily *reclaim road space* (for widening sidewalks or provide more room for bar terraces) can lead to permanent redesign of public space to improve neighbourhood walkability.
- The development of the *bike network* (both at the level of urban lanes and express inter-urban corridors) as a response to the decrease of public transport capacity can consolidate this mode of transportation.
- The increase of *e-commerce and home* deliveries during the pandemic can propel cities to implement actions to improve urban freight transport.
- The *time factor management* has emerged as a key factor to deal with COVID-19 (for instance, fixing time slots to exit home during the lockdown) and point to the interest of time regulations to share some public spaces between different uses.
- Neighbourhood life under restrictions, with fewer cars on the streets, may raise the social awareness of the *quality of life* associated with clean and calm environments with proximity services.
- The intense use of digital technologies to track the pandemic can foster the *use of mobility data* and applications of Mobility as a Service.
- The acceleration of technologies such as *autonomous driving, multifunctionality increase and air cleaning* solutions research and development has been continued by industrial players.

*Successful cities have been able to fast track planned solutions that they have in their SUMPs. This does not happen only due the fact that they have actions planned, but that they have a structure that allows the deployment of such solutions or projects.*

Ivo Cré, Director Policy & Projects, POLIS

These hypotheses mark a direction urban mobility could take. However, it is important to note differences between cities and countries. As it was clear from the survey conducted for this study, not all cities have implemented the same measures or with the same intentions (short term vs. long term). Important to note is the reduced capacity that many Mobility Departments have experienced during the pandemic, limiting their ability to move forward and faster with existing plans.

Nevertheless, this report shows that the window of opportunity is still open for cities to leverage on the behavioural changes that the pandemic created, and fast forward with a sustainable transformation of their urban mobility. However, it will not be easy since there has been an increase of behavioural patterns, i.e. the increased use of cars, that will play against that transformation. Furthermore, sustainability and climate
goals may not extend over time due to the urgent need to act, so relevant actions should take place to achieve them on time. Finally, local governments and transport authorities will need to pay close attention to the economic effects of the pandemic in the transport sector and the role of key enablers (innovation) to tackle existing and current challenges. The following chapters will address these matters.
3 Chapter: Best Practices for resilient & future proof urban mobility systems

The global pandemic has challenged cities to redefine and conceive alternative measures to provide their citizens with safe transportation and continue the development of their mobility plans and strategies. To some cities, the reaction time to implement safe urban mobility measures was shorter, with perhaps limited circulation and available resources. A selection of these resilient cities is showcased in this chapter, presenting the measures that had a significant impact by modifying the traditional assets of mobility (roads, kerbside, sidewalks, public transport, and shared mobility services) and that are shaping new mobility trends.

3.1 European resilient cities

For the elaboration of this report, 16 European cities were surveyed to know the intricacies of their assimilation, reaction, and adaptation to the COVID-19 pandemic. As part of the survey, the cities were asked for five actions that had fostered mobility during the pandemic and at the same time have continued addressing their former mobility challenges.

From the surveyed sample, 5 cities were selected (displayed in Figure 15) by evaluating their implemented actions. The evaluation was based on their level of innovation, contribution to existing mobility plans, contribution to local mobility challenges, and contribution to health safety. An additional selection criterion was the geographic location of the city, this, in order to achieve a representative sample of European measures.

The following profiles provides an introductory overview of the city’s mobility status-quo including a description of the city, its modal split, their mobility challenges before COVID-19, and a brief description of their local mobility objectives. Consequently, three mobility actions are introduced each reflecting resiliency towards COVID-19, sustainability in transportation, or innovation. Additionally, each city profile presents an outlook of the areas requiring innovative actions.
The end of the first lockdown in late April, marked the start of the phase 2, which indicated the restart of Rome’s public transportation. One of the measures implemented to promote safe travelling was the reduction of the passenger capacity of both buses and metro-trains by two-thirds. This was mainly done by de-servicing seats and keeping count of the number of onboard passengers.

To facilitate the transportation of buses, the so-called blue lanes (designated for parking) were suspended until September. This highly improved the service time of buses to compensate for the restriction of onboard passengers.

Alessandro Drago, Local Councilor to Mobility in Rome, mentioned that during COVID, the main objective was to preserve a healthy control of their residents and provide public transport service in a safe way.

On the restriction’s success, Drago stated that social distancing was mostly respected on buses, due to the surveillance of bus drivers. However, in the metro, the situation was different.
**Action 2** Fostering micro-mobility

Within Rome’s three-year Electric Mobility Plan, a city-wide discount for renting electric scooters, pedelecs, and e-bikes was implemented. Rome has a long tradition of motorised transportation, with an estimated 350,000 motorcycle ownership. Therefore, incentives like the discount were needed to encourage citizens towards active transport.

Drago mentioned that the offered economic incentive has boosted the use of micro-mobility by at least 30%.

---

**Action 3** City-wide EV charging infrastructure

To provide charging capacity for the three-year electric mobility plan, 1200 recharging stations are to be installed across Rome by early 2021. According to Drago, Rome is the only city that has approved an electric mobility plan with such ambition. From the total planned charging stations, 750 have already been implemented.

For identifying the ideal locations for the charging stations, the city launched a public awareness and participation platform. In the platform, citizens were able to propose three locations for the charging points. The preference of the public was then taken into consideration for the final locations.

---

**Post COVID-19 Outlook**

After the pandemic, Rome identifies the following areas as future needs concerning innovative actions in mobility:
In Sweden it has been identified that cyclists have suffered more injuries and accidents than other modes of transport during the past decade (Lund Municipality, 2020). 82% of these accidents are caused by poor cycling surface conditions. The project, therefore, intended to reduce the risk of injuries by retrofitting 300 m of the cycle and pedestrian Dalbyvägen path to be “accident-friendly”. They achieved this by laying a surface road made out of mixed asphalt and rubber particles from recycled tires.

An investigation done by 30 cyclists showed that rubber asphalt was considered to be as good or better compared to normal asphalt. The coating is hard enough for easily cycling, but soft enough for it to absorb shocks and prevent injuries in the event of a fall. The “safe-path” concept is the first to be tested in an urban street environment.

The municipality is constantly reviewing the performance of the road surface and its effect on cycling accidents. Special attention is given to the maintenance of the path, how is it affected by sweeping, winter road maintenance and by cars turning over from entrances.
Around 1000 students from Lund’s schools participated in the walking and cycling challenge ‘Find the Way’, which aimed to promote sustainable travel to and from schools. The challenge started with the classes filling a travel behaviour survey to find out how each class transported themselves before the challenge. Consequently, each class collected points in the challenge by completing quests. In the assignments, the students drew their school route on a digital map where they could leave comments about the school route. The data provided by the students are being used by employees of the technical administration as a base for urban planning.

**Action 2**  
*Find the way Challenge*

Astrid Bachs, from the Street and Traffic Department of Lund said that they aimed to encourage children and caretakers to walk and bike to school by making the nearest area around the school safer and fun.

**Action 3**  
*Live Streets around schools*

Since the 1990s, school trips by bicycle in Lund have decreased by 48%. It was, therefore, the purpose of this project to raise awareness of the multiple use’s streets can have and test a temporal solution for reducing traffic around schools. For one week, surrounding streets from several schools were closed for car transit and made available to schools for education and leisure purposes. The initiative was launched as part of Lund’s participation in the European Mobility Week.

Astrid Bachs, from the Street and Traffic Department of Lund said that they aimed to encourage children and caretakers to walk and bike to school by making the nearest area around the school safer and fun.

The liveable streets concept has received positive feedback from Lund’s citizens and schools. However, Bachs mentioned that uncertainty still remains of whether or not it would have foster active transportation on a short or long term.

**Post COVID-19 Outlook**

After the pandemic, Lund identifies the following areas as future needs concerning innovative actions in mobility:
Tartu

**Pop:** 99,631 (647 ca/km²) (2019)  
**Area:** 38.8 km²  
**Budget:** 192 million (2019)

### MOBILITY CHALLENGES

- High car dependency
- Insufficient bike lanes

### Status-quo

Tartu is the second largest city of Estonia, and it is characterised as an academic and research-oriented city with approximately 36% of its population being students (Tartu, 2019). During the past 3 years, the city has been planning the total redesign of transport infrastructures and the implementation of innovative solutions through co-creation processes with its citizens. Within their mobility strategy, the improvement of pedestrian zones, reduction and re-distribution of parking zones, bike sharing systems, and promotion of public transport are targeted. According to Jaanus Stamm, Project Manager from Tartu “Since January 2020 Tartu’s public transport system is 100% fossil free”. Such accomplishment has set apart Tartu from like-sized European cities.

### Action 1  
**Smart Bicycle sharing**

In June 2019, the city unveiled its bike sharing systems, with 500 e-bikes, 250 bikes and 69 bike sharing stations across the city. The projected intended to contribute to label Tartu’s transportation with the motto “anywhere under 15 minutes”. The project received funding from the European Regional Development Fund and the H2020 programme.

The overall vision in the cycling strategy is for the bicycle to be “the preferred all-year-round mode of transport and walking is the preferred mode of travel – the residents of Tartu travel daily mainly by bicycle or on foot.” The Cycle Strategy 2019-2040 will be integrated into the Tartu Energy 2030+ plan, hopefully allowing for harmonization and coordination between several interdependent policy domains. Jaanus Tamm, stated that they used data to strategically decide the location of the stations, identifying the zones with higher pedestrian flow and lower access to buses.

The deployment of shared bicycle has helped Tartu to increase bike usage, however, Tamm acknowledges that more efforts could have been made to foster bike usage, especially during COVID.
With the purpose of accelerating the reduction of car usage, Tartu transformed their existing bus network to one with fewer total routes, better connection between bus lines, and more frequent intervals. For achieving this, the Major of Tartu established 13 new bus routes with 64 new, low emission buses.

The project was conceived with great involvement from Tartu’s citizens to identify those routes where the potential number of bus riders is greater. The buses are also equipped with contactless payment machines.

Defined by Jaanus Tamm as one of Tartu’s success stories in mobility during the pandemic, the Vabaduse Avenue was transformed into a car-free avenue during the month of July.

The project not only observed COVID-19 social distancing guidelines but also gave local businesses an economic relief, as food trucks, a beach bar, flea markets and an outdoor cinema were given a space. An impressive 18,000 visitors were counted in the first three days of opening, according to INHabitat (Wang, et al., 2020).

The pilot project brought topics such as climate change and excessive use of cars back to Tartu’s citizens conversations, so it served as a great awareness campaign.

After the pandemic, Tartu identifies the following areas as future needs concerning innovative actions in mobility:
Santa Coloma de Gramenet

Pop: 118,821 (17,00 ca/km²) (2018)  
Area: 7.0 km²  
Budget: 112 million (2020)

MOBILITY CHALLENGES

Status-quo

Neighbouring Barcelona, Santa Coloma de Gramenet is a densely populated city from Catalunya. An aspect that characterizes Santa Coloma is its high number of pedestrian traffic, according to Jordi Plumed from Santa Coloma’s council, an estimate of 88% of travels in the inner-city is done by walking.

Santa Coloma is located in a privileged position with respect to its access to the road network of the Metropolitan Region of Barcelona, nevertheless this has led to a greater volume of traffic near the city causing an increase in urbanisation and air pollution. Another issue comes with the high number of residents working outside the city, which generates a significant number of daily trips, mostly done by car. To mitigate these issues the city has drafted a PMU – Urban Mobility Plan - in 2017 addressing these challenges.

Action 1 Reduction of Urban Speed

One of the devised actions to tackle Santa Coloma’s high car dependency and air pollution was the establishment of city-wide speed limit of 30 km/h. Travelling at a lower speed reduces the convenience of a car and thus enhances the use of bicycles or walking. A study done in Copenhagen, (where 41 % of its citizens travel by bike) identified that the number one reason for travelling by bike was its convenience over other modes of transport.

Lowering the maximum speed has also provided higher road safety (given the high percentage of pedestrians in the city), and a reduction of air pollutants from vehicles. The Metropolitan Region of Barcelona has in this aspect taken a step forward by aiming to be a low emissions region, therefore, this mobility action would contribute to its fulfilment.
Due to the high density of the city, there is reduced space available for creating additional bike lanes. For this reason, in order to deploy the planned 22 km of bike lanes across Santa Coloma, the existing road was adapted to include a two-way lane. The measure forms part of the strategy to improve the city’s connectivity and infrastructure for bicycle users.

An additional type of bicycle lanes has also been conceived under this action, this is the so-called “bicycle streets” in which priority is given to bicycles over vehicles. Vehicles can travel only in one direction, whereas bicycles can travel in both. Travelling speed for vehicles is restricted to 20 km/h to increase safety for bike-users. The bicycle path extension project was developed in three phases.

**Action 2  Increase of time for pedestrian traffic light**

A direct measure established by Santa Coloma for promoting social distancing during the pandemic, was increasing the waiting time for pedestrian traffic lights. Having a modal split of 88% pedestrian travels, the city’s sidewalks, and street-crossing zones are areas in which distancing could be difficult. This measure has also reduced the convenience of car usage.

Walking fostered also through the “Metrominuto” program, which has represented the walking routes and its duration across the city like a metro line.

**Action 3  Expansion of bicycle path**

Due to the high density of the city, there is reduced space available for creating additional bike lanes. For this reason, in order to deploy the planned 22 km of bike lanes across Santa Coloma, the existing road was adapted to include a two-way lane. The measure forms part of the strategy to improve the city’s connectivity and infrastructure for bicycle users.

An additional type of bicycle lanes has also been conceived under this action, this is the so-called “bicycle streets” in which priority is given to bicycles over vehicles. Vehicles can travel only in one direction, whereas bicycles can travel in both. Travelling speed for vehicles is restricted to 20 km/h to increase safety for bike-users. The bicycle path extension project was developed in three phases.

**Post COVID-19 Outlook**

After the pandemic, Santa Coloma identifies the following areas as future needs concerning innovative actions in mobility:
Two of the most pressing mobility problems in Lindau are its high traffic flow from non-residents and a declining air quality. According to their KliMo Concept, the latter problems are mainly due to a 78% car usage of non-residents when travelling into the city.

To solve this issue, park & ride stations were constructed in two strategic locations, in which visitors can park their cars and then take a shuttle bus into the inner-city and island. To foster this measure, the city decided to restrict the available public parking space in the island, thus forcing the usage of the park & ride stations. Residents were pessimistic at first from this action, nevertheless, according to Jaime Valdes, Mobility Project Manager in Lindau, it has proven to be a successful project to reduce traffic in the city.

Valdes mentioned that due to the travelling restrictions imposed by the pandemic, Lindau received a higher number of local tourists causing a higher demand for parking space. Usage of data and AI to control traffic flow could, therefore, be the next step in Lindau’s mobility strategy.
### Action 2  
**Stadtradeln Lindau**

The European Mobility Week (EMW) is a campaign to promote sustainable mobility in cities and communities. The motto for 2020 was "Smart on the move - live better!". From 14 to 20 September 2020, Lindau was taking part in the EMW for the fourth time with different actions. During the whole week the City turned the Paradise Plaza where normally cars park all around into a Living Park and showed who - “Living spaces instead of parking spaces” could be revitalized. Information stand and many more activities were held during this week.

![Photo Credit Jaime Valdes (2020)](image)

### Action 3  
**Intermodal Innercity Mobility – KliMo Stations**

In order to reduce the usage of private vehicles, the city developed an intermodal mobility strategy. The strategy was conceived under the KliMo concept and involved the creation of KliMo-Stations (Bike & Ride stations) in which people can continue their journey either by bus, train or taking a ferry directly to the Lindau island. The stations deployed are 10 Bike & Ride stations. In these Bike & Ride stations, the city included charging plugs, to make available charging infrastructure and Service Points for small repairs. The latter has been useful for Lindau’s citizens during the pandemic, as there has been a notable increase of active modes of transport.

![Photo Credit Jaime Valdes (2018)](image)

### Post COVID-19 Outlook

After the pandemic, Lindau identifies the following areas as future needs concerning innovative actions in mobility:

![Internal Cross-Silo Collaboration](image)
3.2 International Best Practices

One prominent feature of the innovative collaboration that has taken place in the past year that has emerged is the strong potential to spread best practice and innovative measures. It is interesting to see such a large knowledge base being made available in such short time. International examples of best practices are showcased here. Some of the most relevant best practices from around the world regarding urban mobility responses to the pandemic are highlighted below.

Bogotá, Colombia
Pandemic Mobility Responses Hackathon

In March 2020, the city of Bogotá partnered with the New Urban Mobility Alliance and other organisations to bring various experts together to come up with the best possible initiatives to improve mobility in the city in response to the pandemic. The event lasted 4 days and was called the MOVID-19 Hackathon, with cash prizes for the best solutions. Initiatives that came out of the hackathon included a pilot to provide e-bicycles to healthcare workers, as well as a program to create new bus routes specifically for them.

By creating this space for public health and transport experts to collaborate, Bogotá stimulated greater innovation and increased the city’s resilience to the pandemic. It is important for cities to consider ways like hackathons to involve its citizens in mobility planning.

The pandemic created a unique urgency to implement new mobility initiatives and Bogotá took advantage. For example, as a direct result of the event, the municipality partnered with a private bike operator, MUVO, to provide 400 bikes to Bogotá’s health care providers and the Secretary of Mobility coordinated with the city transit system, TransMilenio, to implement some of the other proposals.

Bogotá had several partners supporting this initiative, which contributed greatly to its success. By showing willingness to not only hold the event but quickly implement the best ideas, the city gained credibility with its citizens and made it easier for similar events to be successfully held in the future.
Auckland, New Zealand

Auckland Transport Mobile App Updates for Public Safety

In March 2020, New Zealand had implemented Level 4 restrictions, meaning public transport could only be used by essential workers and by people on their way to essential services, such as to purchase groceries. Auckland Transport quickly upgraded its app, AT Mobile, to show live occupancy statuses of buses. This allowed passengers to make informed mobility decisions about their health and safety.

The Hackathon in Bogotá was an example of using digital tools in a bottom-up planning approach. This example of a Best Practice in Auckland shows the value in using technology to effectively spread dynamic information to make urban mobility as safe as possible during a pandemic.

Mexico

National Mobility Plan for a New Normal

In order to guide response to mobility issues during and after the pandemic, Mexico created a guide called the Mobility 4S Plan for Mexico: Health, Safety, Sustainability, and Solidarity (*Saudable, Segura, Sustentable y Solidaria*). The document is an unprecedented joint effort by four national ministries, the World Health Organisation, and over a hundred civil society organisations. It is primarily aimed towards local and regional authorities.
Stuttgart, Germany

Monitoring physical distancing compliance with 3D sensors

Like many centres of travel and mobility during the pandemic, Stuttgart Airport has encouraged 1.5-meter social distancing with floor markers showing passengers how far apart to stand from one another. What separates Stuttgart Airport’s attempt to keep passengers safe in this manner is their monitoring system. The airport is using 3D stereovision sensors to understand how effective the queuing layouts are at facilitating distance.

The artificial intelligence powered sensors can accurately detect the location of a person within 20 cm. No personal information is captured; the person appears as an anonymous dot. The dots can then be used to create heat maps of where passengers fail to adequately distance themselves, allowing the airport to adjust the queuing layout accordingly. The program also calculates an indicator of the average number of collisions per person and how many times the minimum physical distance was encroached.

Recommendations include increasing pedestrian areas, distributing face masks, implementing speed limits, creating super city blocks, monitoring transportation levels, bicycle incentives, parking spaces for micro mobility, and exclusive lanes for public transport. The almost 200-page document was published in September 2020 in three volumes.

Mexico is among the countries worst affected by the pandemic, with the highest mortality rate per case and a projected increase of 12 million people living below the poverty line. The 4S areas mentioned will be more important than ever, and this effort to inspire a transformation of the mobility sector by the national government, WHO, and other partners provides a valuable guide for how Mexican cities should proceed, and hopefully achieve lasting positive change in the wake of the pandemic.
It was made possible through an already existing partnership with a technology company, Xovis, who had installed the sensors years earlier to help manage people flow in the airport. Leveraging these sensors to increase passenger safety in public transport such as in central railway stations should be considered.

Cannes, France

Monitoring Mask Compliance with Artificial Intelligence

Another example of monitoring the effectiveness of mobility safety measures in the wake of COVID-19 using artificial intelligence can be found in the bus system of Cannes, France. Small CPUs were added to the existing bus cameras and can detect and process mask compliance statistics in real time. When the buses return to the depot, they send the data over Wi-Fi to the local transportation authorities who can then see what routes need more resources to increase the mask wearing rate. The figure below shows an example of the dashboard generated. Again, the information is completely anonymous and only used to evaluate the effectiveness of current measures.

The technology, which is implemented by French start-up DatakaLab, has been in use in Cannes since April and has had trial implementations in other parts of the country, including at Chatelet-Les-Halles station in Paris. It is another example of innovative technologies that have been developed in response to the pandemic to better inform policy, resource allocation, and communications in urban mobility. Similar technologies have been implemented in Switzerland and the United Arab Emirates.
4 Chapter: Innovation in cities as enabler of the transition

4.1 Introduction

A sustainable mobility system requires innovations. Innovations in the field of technology, organisation, financing and other fields, that together supports the transformation of urban mobility. To make that whole system of systems work together, organising collaboration within cities is key. Even though the playing field for this is evolving and new stakeholders are joining the game, local government will be central to it all. Therefore, this chapter tries to explore some of the issues that might help cities, and especially local government, to organise for collaboration on innovation, and so better be prepared to transform their mobility systems. As this field has less of statistics, data collection, established practices and taxonomy compared to traditional perspectives on mobility, the chapter tries to approach the subject by outlining some important aspects on how cities work with innovation, and what might be needed to better enable the transformation of urban mobility. The main perspective is that of an urban innovation practitioner.

The chapter is written in the moment the second wave of COVID-19 is hitting Europe. It is hard trying to both follow and analyse the everyday changing situation and how it affects mobility in cities, as well as what innovative measures are taken by individual cities. Getting a comprehensive overview is impossible. It seemed probable that cities learnt a lot during the first wave, and are now applying that, while at the same time adapting short term actions to more long-term measures, and also applying strategic planning for long-term changes and investments. But the survey and the interviews showed that cities have in most cases not been able to look to the future yet. Most of reflections and learnings are in the very early stages, and much of strategic thinking has been put on hold during the crisis. So, what is discussed in this part of the report can be used and applied when local municipalities and other stakeholders in the urban mobility sector start looking to the future in a more structured way from 2021 onwards. At that time, it will be important to give early attention to considerations about how to organise innovation collaboration for the transformation of urban mobility.

So far actions have mostly been based on the individual city’s own experiences of how the pandemic hit locally and what restriction were applied. This differs substantially between cities, and even more between countries – regarding the actions taken as well as the perceived need for more long-term changes in mobility strategies and innovative transformation of the mobility system. At the same time the sharing of ideas and solutions has been increasingly supported by a plethora of resources, collecting good examples, reports and research, creating a body of knowledge cities can benefit from. This is valuable as the long-term strategic decisions in cities on the future mobility system need to be based on best practice, taking into account both the pandemic and the broader set of requirements on cities sustainable mobility systems.

To better understand how cities can organise their work with short-and long-term innovation for transformation of their mobility systems to be aligned with future requirements, it might be useful to mention something about innovation work with complex challenges in cities.
4.2 **Mobility as a wicked problem**

The transformation of the mobility system is already under way, impacted maybe foremost by climate change and new technology (see 1 Chapter). The pandemic adds a new layer to the requirements for the future, a layer affecting many other city systems through cascade effects (see Chapter 2). There are obvious interlinkages between mobility and other strategic areas of city transformation like digitalisation, energy, placemaking, working life, service sector etc. In these interdependencies, new needs and opportunities for innovations arise. The mobility system must be seen in the context of the total city systems, and innovation and strategies need to take that into account. City mobility system transformation should be taken on as a wicked problem.

Wicked problems have characteristics that make them hard to tackle. They involve multiple stakeholders, each with their own cognitive frames, values, norms and interests. The preferred solution is linked to the chosen perspective and definition. They have no stopping rule, and there are no criteria for a sufficient understanding of wicked problems or the length of their causal chains in an open system. Wicked problems also involve fundamental uncertainty and unpredictability. They cannot be solved without collective learning and reframing processes that reduce this uncertainty to a manageable level. The way to work with wicked problems will, based on the characteristics, be one where a multitude of perspectives and competencies in a complex process are negotiating both the questions and answers in a collaborative learning process to find solutions.

This means the stakeholders involved in mobility challenges and coming up with innovative solutions for those challenges must come from a broader field of stakeholders than the field of mobility alone.

4.3 **Innovation, collaboration and governance models**

Working with innovation across boundaries and silos internally in a city administration is a challenge. Even more so is working both across silos and with diverse groups of external stakeholders. Understanding each other and creating trust and a common vision is key to find the best solutions and innovative measures. This requires understanding different stakeholder’s “business logic”.

The means used to stimulate, support, influence or in other ways “manage” the interactions between different stakeholders is called governance. There are three basic models of governance – hierarchic governance based on jurisdiction and control, market governance based on prices, transactions and efficiency, and network governance based on co-operation between different stakeholders.

When using different governance models within your local innovation ecosystem, the different stakeholders have different “default” models. Companies tend to use market-based governance, entrepreneurs use network-based governance and cities tend to use hierarchical governance. When
diverse stakeholders work together, they need to expand their thinking and actions across boundaries to other governance models and logics.

There is also need for understanding that local government need to act differently depending on what kind of problems they need a solution for. For traditional municipality services, let’s say local bus transportation or speed limits within the city, local government often has control. Here the hierarchical governance works fine, and the role, the delivery and the results are clear.

But the city is more than government and public sector activities. Many more stakeholders can support the transformation of the city by creating new solutions within their own fields of operation, and so create value for the city as a whole. This means that the city should also support collaboration, innovations and solutions that deliver results outside and independently from the government domain. For many challenges the municipal mandate for action is shared with others, or non-existent. An example could be the emerging trend that housing companies include mobility services in the rental offer to reduce need for parking space and attract tenants that don’t want to own a car. This is outside the control of local government but affects the municipality mobility system. Here other forms of governance and collaboration modes are required.

The three-colour playing field model, developed by Future by Lund, the innovation team of the City of Lund, Sweden, illustrates this. It can be used to identify where different aspects of the challenge need to be negotiated and solutions can be co-created. City of Lund uses it to analyse different aspects on smart sustainable city development, what stakeholders need to be involved and what role they might play. If there is need for something to happen that is outside the local government mandate, they try through dialogue processes to initiate groups of stakeholders that can drive initiatives in response to that need. Sometimes this is facilitated by the administration by initial funding, or by opening resources within the administration to the external stakeholders. An example is new technology for charging vehicles during driving, where the city first helped the entrepreneur with seed funding, then with testing ground and finally with real-environment testing on a city street (Elonroad, 2020).
4.4 Action space and relational space

Trying to solve city challenges includes exploring new innovative ideas and concepts with a diverse group of stakeholders. There is a need for actions creating tangible values that can be of interest for the participants, and there is a need for understanding and trust. These two dimensions of collaboration can be presented as action space and relational space. Both parts need to be understood and managed if collaboration is to reach its full potential.

To find motivation for collaboration, individuals and the organisations taking part need to see a potential for tangible value creation, making it meaningful to allocate time and resources in a collaborative effort. This value creation can be new market opportunities, increased performance in existing operations, a better quality of life for citizens or something else perceived as valuable. What that is depends on the objectives of the organisation concerned. Participating stakeholders need to see the often concrete and short-term results that will be created. It is about decisions, investments and execution. These kinds of action-oriented relations that are established between the partners in collaboration are necessary. This dimension of the collaboration constitutes the action space.

At the same time collaboration need to be based on understanding and trust between the partners, in order to guide their participation with clear roles and high motivation. Partners need to know what to
expect from the others. Otherwise, the planning and execution of the collaboration will be weaker and more vulnerable, as the risk of disappointment and misunderstanding between partners is higher. This part of the relationship is often less in focus, as it is an “investment” which is often seen as taking too much time. This dimension of the collaboration, learning to understand and trust each other, constitutes the relational space.

Cities working with innovation as a driver for transformation, especially wicked problems like future mobility systems, need to engage in this type of more inclusive and complex collaboration processes, work with different governance models in balance, take the playing field into account and take care to focus both on action space and relational space (Edelstam, 2016).

4.5 The short-term impact of COVID-19 on innovation collaboration

Processes to work with complex collaboration on innovation are best created in live meetings, using different tools and methods for creating trust and sense-making among stakeholders, including citizen participation. This way of work is hampered by the pandemic, as real-life meetings are reduced. Remote work has an impact on how teams work, and how innovative teams might be, especially when it comes to cross-silo work or teamwork involving stakeholders from different groups/interests where trust is a key component of collaboration. On top of this comes the budget restraints that is caused by COVID-19.

So, the pressing need for innovative measures and transformation of mobility system is high, at the same time as the practical conditions for the multi-stakeholder work needed is under stress. This creates a situation where both the substance and the format of innovation and mobility needs to be considered, and where learning from best practice is key.

Cities have urgent needs to take action in the coming years, both short-term and long-term to transform their mobility system to meet future requirements. At the same time very large amounts of money will be coming in EU programs for recovery and climate investments, suited to be used for this transformation. This urge for transformation, the many stakeholders involved and the complexity of the challenge, and the size of financing coming are parameters that all stress the need for cities to prepare and organise for innovation.

4.6 Organisation of innovation work in cities

Cities work in many ways with innovation. This include technical innovation, organisational innovation, innovation in financing and digitalisation and other aspects that are needed. As pressure from climate change increases, and the pandemic causes both short-term shocks and long-term new requirements,
while technological development and digitalisation rapidly create new opportunities, organisation of innovation in cities grows more important.

The pressure on local government to handle complex development challenges with limited resources is increasing. But looking at mobility, or other complex and wicked problems in cities, it is clear that the transformation can’t happen only within the domain of local government. The city can manage public transport, but private transport is harder to transform with the means at disposal of local government. Interdependencies and cascading effects between different systems must be handled. To a large extent challenges are defined and handled, and solutions created in the green and yellow zones of Lund’s visualisation of the “playing field”. This emphasises the need to organise city innovation not only cross-disciplinary and cross-departmentally internally, but also open up for partnerships with external stakeholders.

Understanding the system challenges and interdependencies between different areas of responsibility, many cities have started to organise their innovation work to be cross-silo functions, using competencies from many departments. This might be done on a project-by-project base, or as normal day-to-day collaboration routine. Establishing an innovation strategy for the city seems to be a success factor as cities having a formal innovation strategy reported being more experienced with activities that foster innovation than those that do not have a formal strategy (OECD, 2019).

In many cities the experiences from such work have led them to establish specialised innovation functions, positions like Chief Innovation Officer or dedicated innovation teams (Puttick, Baeck, & Calligan, 2014).

OECD reports that innovation units can help overcome barriers to innovation through their different functions. Innovation teams have five broad functions: 1) supporting and co-ordinating the implementation of innovative solutions; 2) experimenting with different approaches to problems; 3) supporting cross-cutting and interdisciplinary projects; 4) ensuring the resources needed to give emerging ideas the space to grow; and 5) building capacity and networking support (OECD, Fostering Innovation in the Public Sector, 2017).

The OECD report Enhancing Innovation Capacity in City Government (OECD, Enhancing Innovation Capacity in City Government, 2019) gives an overview of the status of city innovation based on local government initiatives and organisation. As respondents in the survey the report is based on is dominated by North American cities, the results might not fully reflect the European situation, but as much of the issues are generic there should still be strong relevance for European cities.
According to the report the emergence of innovation teams in local public administration is a relatively new approach, as only 21% of such teams have existed for more than five years. Around half of innovation teams sit in the mayor’s or city manager’s office, and nearly 30% have their own department.

“In terms of city operations and functions, creating an innovation team and engaging in innovation activities is still a relatively new approach. In many countries, cities are still building up their knowledge base to coordinate and assemble the right organisational, financial and human resource infrastructure to support their efforts.” (OECD, 2019)

So, innovation teams, working cross-cutting and interdisciplinary, are important to help in making established innovation strategies operational and boost the implementation of innovative solutions in cities. In many ways they can be seen as a response to the complexity and speed of transformation needed, that puts pressure on local city government in solving challenges. The teams are often positioned organisationally “close to the heart” of the city, and as cities have an abundance of challenges internally within their own domain of control, they tend to have an internal administration focus. The cities are aware that they need to interact with external stakeholders, but internal cross-departmental often occupy most of the time and resources.

By tradition innovation is normally handled within departmental silos in cities. From that “normal mode”, there is a trend that cities develop their work on innovation on scale, reaching from a couple of departments working on innovation in common projects, through inter-departmental innovation functions, formal innovation strategies that impact much of city work, to fully dedicated innovation teams, often working cross-silo internally, but in the more advanced cases also having well developed collaboration with a range of external stakeholders, representing different sectors.

4.7 Who should be involved?

Cities are differently organised in different countries as well as depending on size, so there is no “off-the-shelf-list” for who needs to be involved. Still, it is easy to understand that internally in the city administration departments working on transportation, streets, city planning, economy, climate and environment, procurement, digitalisation and citizen engagement need to be engaged. COVID-19 makes it necessary to include health services and crisis response functions. Externally, professional bodies in the field of mobility, government and transport authorities, and mobility solution providers including the digitalisation sector are key players. Through the COVID-19 crisis even more stakeholders have become relevant. These include sectors like real estate companies where changed workplace patterns will influence mobility, and store owners as they will be affected by changes in mobility patterns. As the transition will require new infrastructure, financing companies from the construction sector and from the financial community will be part of the process.

It is clear that such diverse engagement will need to be organised in a structured way, using well proven practices and tools for collaboration, to build a strong base for the transformation of a city’s mobility system. It seems likely that a traditional setup with innovation integrated in the different departments will not be able to handle this the best way and deliver strategies and innovative measures at international frontline, and so future proof the decisions and investments that need to be made.
“As mobility has no clear owner of the problem, there are many different stakeholders, and the model for collaboration needs to be innovative in itself.”

Dr. Anna Clark, Innovation Lifecycle Manager, EIT Urban Mobility, Innovation Hub North

For cities that want to start this work in their local government there are good tools and work models available at NESTA (NESTA, 2014; NESTA, 2020) (OECD Observatory of Public Sector Innovation, 2020)

4.8 A snapshot of innovative measures and mobility strategies due to COVID19 crisis

Transformation of urban mobility is a wicked problem with interdependencies and synergies with other areas of city development. The COVID-19 crisis adds to the complexity. Just think about how the pandemic reduces the appetite for using public transport, reducing demand and reducing revenues from fares (see Chapter 2). Low-income households that can’t afford a car will have higher risk of becoming infected. At the same time remote work additionally reduces commuting demand and revenues, also affecting timetables and need for buses and staff, even parking in cities or need for office space. For individual transport biking have increased, while e-scooters and different forms of mobility as a service slumped. Car-sharing goes down. Car use for recreational travel increases if the citizens are not willing to use public transport, or if restrictions stop travelling abroad by flight. Increased internet shopping and home delivery drives cargo transport reduces shopping travel and changes the basis for both city centre stores and shopping malls.

What of all this will be, at least partly, lasting changes affecting city planning and mobility system planning and investments? And which stakeholders need to be involved to understand the changes and the potential solutions? During the COVID-19 crisis interesting ideas, actions, projects and analysis relating to innovation as driver of the transformation have started to emerge.

A recent report by Arthur D Little (Arthur D Little, 2020) consulted 30 organisations from three major groups: professional bodies, government and transport authorities, and mobility solution providers. The report assesses the likely impact of COVID-19 on future mobility patterns and provides a valuable summary of more than 100 actions that transport authorities and mobility solutions providers are taking, or planning to take, in response to the crisis.

The report identified three game changers for city governments and authorities to frame and enable mobility systems for the post-COVID-19 world:

- **Game changer #1 Think and act at system level: Develop a unified long-term mobility vision.**
- **Game changer #2 Foster innovation through public-private collaborations on innovative technology and business model development.**
- **Game changer #3 Set up a Unified Mobility Management Model, enabling real-time optimization of mobility flows and assets at city or national level.**
The report draws on the broad competencies of a diversity of mobility stakeholders and give interesting insight on future trends and options for actions.

Still, if the interdependencies and cascade effects from COVID-19 are taken into account on other sectors than mobility, it is clear that stakeholders outside the “usual suspects” group consulted on the Arthur D. Little report need to be engaged in analysis and scenario building, as well as in innovation work and partnerships, aiming for the right transformation.

With local government in the lead for COVID-19 measures and for much of innovative measures and strategies for urban mobility transformation, there is still need for other stakeholders to engage in supporting those innovations. With so much happening it is hard to get an overview of what special attention innovation as transformational driver had in the first nine months of the pandemic, but a few examples may illustrate innovation initiatives.

A mobility focused initiative is EIT Urban Mobility’s funding of innovative projects to address urban mobility challenges posed by the pandemic (EIT Urban Mobility, 2020). All projects address the EIT Urban Mobility strategic objectives, while interpreting these in context of a COVID-19 response. They will generate immediate impact as the implementation will take place already in 2020 with a duration of four to six months for each project. The projects are ongoing, and results will be published during 2021.

On national level engagement TAFTIE, the European Association of leading national innovation agencies, made a survey among their members about measures for Pandemic mitigation (Vinnova, 2020). Almost all have launched such measures directed to the health and/or related sectors, and some of them also play a role in other agencies pandemic mitigation actions. It seems, though, that only small parts of this have direct relevance for the mobility sector. The link between COVID-19 and mobility is not handled in the short-term measures but might be expected to be integrated in programs and calls directed towards areas like mobility, new technology, city resilience or start-up funding. The effects will then probably be more visible in the coming years.
The Emergency Governance for Cities and Regions Policy brief #01 (London School of Economics and Political Science, 2020), presents a survey of the Emergency Governance Initiative included 57 cities in 35 countries. The main findings show “that innovation as part of the COVID-19 response was particularly common for the emergency governance domains of: (1) leadership and authority, (2) cooperation and collaboration across key stakeholders and (3) information technology and data management.” This reflects the cities’ flexibility for working in innovative ways both across stakeholder boundaries and using data as a source for innovative measures. The data covers overall responses and is not done with specialised questions on mobility. A subsection (p. 5 of the Emergency Governance for Cities and Regions Policy brief #01) summarises the geographic and thematic focus of international knowledge platforms and resources that are currently available to city and regional decision-makers to aid their crisis response. Out of 60 analysed COVID-19 monitors (international knowledge platforms and resources), ten focus on urban transport.

Nesta, the United Kingdom innovation foundation, is doing research exploring change within local government due to COVID-19 (NESTA, 2020). In the initial findings they concluded “there is a sense that the severity and urgency of the crisis has brought about many positive changes: it helped increase collaboration with communities and other actors, devolved power to front line staff and led to mass digitisation of services. As local authorities are starting to plan for recovery and the easing of lockdown, they are thinking of ways they can capture the lessons emerging from this experience and ensure they will be able to hold on to these positive changes beyond the crisis.”

Collaboration and digitisation seem to be at the core of local authority response in the researched UK cities.
A common purpose, and working in cross-organisational teams, has broken down silos. The challenge is now seen as how to hold on to those practices (results from late May). This illustrates the ability of cities to work differently, but also the gravitational power of business-as-usual.

In a situation with lack of overview, the above are just examples on how stimulation for transformational innovation is seen and managed at the moment. Still, it seems the matching between requirements on the future mobility system in cities, the support for innovation as driver, and the involvement of relevant stakeholder for the transformation has potential for improvement. The responsibility for finding solutions rest with cities. So, cities need to organise for innovation in collaboration with broad stakeholder groups, while simultaneously work to find the financing to support them.

### 4.9 The need to align different levels in the system

For a city working to meet COVID-19 with innovative measures, concrete and quickly operational actions in the field of mobility was required. The national level response has so far to a large part been directed to restriction measures and broader support for the upholding of a functioning society with support to healthcare, for jobs and for the business sector.

In the acute phase cities’ mobility measures needed to focus heavily on the pandemic, but in the next phase the measures need to start integrating the overall requirements for a future mobility system. For such a

---

5 See page 6 figure 5 for more details at (London School of Economics and Political Science, 2020)
long-term transformation there is need to align strategies from city-level up to national and EU-level measures

It seems cities during COVID-19 have been able to find a new level of cross-silo collaboration and innovative measures. It is important to sustain this ability and capacity as cities go into new phases of both meeting the second wave of the pandemic and at the same time handling a broader set of future requirements on their mobility system. Then organisational issues become even more important. Cities institutionalize new ways of working, and the national and EU levels need to support them in this work. In upcoming major EU-funding programs and recovery schemes, this should be an integrated part.

4.10 Results from the survey

As described in the Introduction section of this report, the survey results should be seen as a snapshot of the situation, but a snapshot that can be used as basis for a qualitative discussion about effects from the pandemic and possible measures to take concerning actions, strategy and organisational issues. Thus, it is possible to comprehend the results that can contribute to such a discussion.

Organisation and collaboration are two key areas for successful work with urban innovation. The majority of responding cities show a traditional organisation with no cross-silo innovation function.

![Image](Figure 19 – Survey results from the question: How is the work with innovation organised in your city?)

This indicates they organisationally should be less flexible and potentially have a weaker capacity and capability to work with innovative solutions and external collaborations for transforming their ability system than frontline cities.

When it comes to engaging with external stakeholders, the survey shows that local government engagement with other public sector organisations score highest, but also citizens and to some extent universities/research organisations have been engaged more than different categories of private sector stakeholders.
Collaboration with private sector is something for local government to consider carefully. There are both risks and opportunities in doing it, but it’s obvious that with the right setup, there is much knowledge, services and financing that might come from the private sector that can contribute to transforming urban mobility system. This collaboration is increasingly important and learning from frontrunner cities in how to organise and “control” collaboration will be beneficial.

“City governments need to think about what framework conditions they can set up, making it possible for private companies to find working business models, that at the same time are in line with the city’s policy goals.”

Dr. Anna Clark, Innovation Lifecycle Manager, EIT Urban Mobility, Innovation Hub North

Considering citizen involvement, it is encouraging to see a good amount of activity, and that cities under stress still have the ability to open up both for formal processes and for proposals on mobility measures from citizens.
With a more traditional organisational setup, engaging citizens is still natural for cities. Engaging with other stakeholder groups is more challenging, especially when it comes to private sector, and it can be wise to learn from cities being experienced in public-private-partnerships.

When looking into the details of the survey to understand what kind of innovative measures are taken, it looks like much is related to the acute situation, rather than taking a broader set of future requirements into account. There is a lot of focus on alternative modalities with different biking schemes as the most common action, but also new measures concerning public space and mobility as a service seem to be explored in many places. Some cities also test new mobility apps. Most of this are reversible actions, though in a few places measures for strong increase in bike-lanes is more of system development (for more details, see chapter 2).

“During COVID-19 it seems that cities got the opportunity to speed up implementation of some already planned measures, but there was less opportunity to focus on innovating on strategy. There is willingness to re-evaluate strategy, but due to the acute situation, most often strategic issues have been left for the future.”

Dr. Anna Clark, Innovation Lifecycle Manager, EIT Urban Mobility, Innovation Hub North

The potential gamechanger is, however, what will remain of new work methods and new measures after COVID-19.
After the COVID-19 crisis, please indicate if any of the following is being planned or identified as future needs concerning innovative actions in mobility?

These results need to be read with great caution, as the answers in many cases are given during the second wave of COVID-19 starting to grow, and what will be part of future planning is to a large extent too early to tell. Still, it seems to be a tendency to increase citizen involvement in the future, and potentially also increase both focus and financing on innovation collaboration. Bigger organisational changes are not on the agenda among respondents at this stage.

Looking at measures taken, and the answers on what will prevail after the pandemic, it seems too early to tell if the crisis will be a vector for steering strategies and actions into a more sustainable path. However, this is a strategy decision that cities need to look into, as the pace of change will not slow down, and investments that will be made in the coming years as part of the recovery after the pandemic need to be long-term.

Research from the C40 Mayor’s Task Force on Green and Just Recovery indicates that only 3 - 5% of an estimated US$12 - $15 trillion in international COVID-19 stimulus funding is committed to green initiatives (C40 Mayors Recovery Task Force, 2020). They recommend such funds should be channelled towards investments like mass transit, walking and cycling infrastructure and clean energy.

The gap between upcoming resources versus cities’ readiness to prepare for the planning and collaboration that transforming urban mobility systems need to be addressed, both on local government level and by the different financing programs that will disperse the financing. There is a window of opportunity to channel some of that funding, so cities get support in establishing both capacity and capabilities on innovation, collaboration and the use of data to support that.
4.11 Other emerging strategies from an international outlook

One prominent feature on innovative collaboration having emerged during the pandemic needs to be mentioned. It can’t be dedicated to any individual city or organisation, but still have strong potential to spread best practice and innovative measures. It is all the online platforms and repositories of reports, cases and learnings on overall COVID-measures, where some relates to mobility and innovation. It is interesting to see such a large knowledge base being made available in such short time.

4.12 Data as driver of transformation

Data has been a key asset for many cities when it comes to analyse the effects of COVID-19 and to take measures to meet those effects. Much of the data has been related to health, but also data in the field of mobility has been valuable to meet the rapidly changing mobility patterns when restrictions were applied, and when individual’s behaviour on mobility changed due to fear of getting infected. In the survey, it was included one question on data as enabler in mobility planning.

![Survey Answers from the Question: What role has data collection and analysis played in the mobility plans and, especially, during the pandemic?](image)

Figure 23 - Survey Answers from the Question: What role has data collection and analysis played in the mobility plans and, especially, during the pandemic?

The question refers to using data for planning, focused on the acute situation of a pandemic. More than half of the cities have been applying data to adapt mobility planning. There is a potential overlap between this option and the next alternative, where five cities have applied data to plan mobility policies but point to the deficits in available data to have a holistic understanding. The cities that have used data seem to have applied it most frequently to adjust public transport to a changing demand, to increase cycling and to

---

6 Examples can be found both on COVID-19 in broad context (GOVLAB & Lumina, 2020), and more focused on mobility issues (EIT Urban Mobility, 2020) (POLIS, 2020).
understand how citizens use public space. At least some of them have used data also from external stakeholders like Apple and Google, which offered them additional insights about visits length of stay change over time to public areas and stores, as well as changes in volume of people driving, walking or taking public transit (Migration Data Portal, 2020) (Apple, 2020)

It is interesting to compare responses with a more comprehensive OECD study on innovation capacity in cities. (OECD, 2019) With participation from 89 cities, it looked into how municipalities are innovating, why they are innovating, and what innovation is allowing them to do. For 85% of surveyed cities, data play a significant or somewhat significant role in innovation decision making and policy making. However, data availability by policy sector remains uneven.

The answers about data collection and analysis from our survey can also be contrasted to the results from the OECD study’s question “Does your city have sufficient data in the following policy areas to support your work on innovation?” Out of 89 cities 64% responded positive for transport/mobility, making it the highest scoring policy area for availability of data. This could indicate our sample are cities that as group have lower maturity on data collection and use, and so have high potential to improve when it comes to collect and use data for analysing and improving their mobility work.

“Most cities are not ready to collect and use data more extensively. There is lack of staff, lack of knowledge, lack of collaboration with private sector. City administration needs to mature on collection, use and collaboration on data.”

Daniel Serra, Innovation Hub South Director, EIT Urban Mobility

The OECD’s Observatory of Public Sector Innovation has established a four-phase typology for the use of data and information. It consists of: 1) sourcing – the origin of data, information and knowledge; 2) exploiting – preparing information and data to be used to meet organisational challenges; 3) sharing – the information and data to support decision making elsewhere in the city; and 4) advancing – learning and generating knowledge from the organisation’s own experience. (Observatory of Public Sector Innovation, 2017) Using this typology cities also need to address the challenges of which data and for what purpose.

Data is collected and analysed by diverse stakeholders. It might be transport service providers on local or regional level, data on remote working by large companies, telecom companies having cell phone localisation and use data, credit card companies’ user data, e-scooter companies or vehicle sharing services, autonomous vehicles, public space sensor owners, IoT-connected devices. But also data about heatmaps of cities and use of public space, or data from social media, are examples of data sources that might be relevant. A clear example of collaboration between different data owners was brought by the pandemic, where 14 Mobility Network Operators in 19 EU Member States and Norway provided data to the EC’s Joint Research Centre to understand virus spread, containment, and impacts on mobility. Another example has been the New York City’s Recovery Data Partnership where the City Council started a collaboration with data partners from the private sector (such as Street Easy, LinkedIn, Cuebiq, Foursquare and SafeGraph) to better understand the impacts of COVID-19 in the city and better design recovery strategies for the city (Leger, 2020).
“We need data and we need to ask the right questions of the data to support innovation for future mobility. Getting access to the right data most often requires public-private-partnership collaboration.”

Dr. Anna Clark, Innovation Lifecycle Manager, EIT Urban Mobility, Innovation Hub North

So, facilitating access and sharing data that can support better planning of the mobility system will be increasingly relevant. With that comes some important and current issues that cities need to address when working with data.

The first is about privacy and integrity for individual/citizens. The view on this varies between different countries and parts of the world. Cities should not go for individual standards, and so would benefit a lot from having this regulated on European level. Several regulations and policies are already in place such as the General Data Protection Regulation or the new European Data Strategy. However, there are related consequences that are not fully addressed by existing regulations. For instance, ‘those who have access to the data and thus control the information, have immense power. This, in turn, means that the data and information are at risk of abuse which can result in market distortions, security risks, and diminished privacy protection, among others’ (Serafimova, 2020, p. 6).

The second issue is about the business case for data. Here difficulties occur. There are plentiful pilot schemes on business models for urban data, but challenges remain. For the local government it might be good to start with establishing principles for how to govern urban data, building on results from URBACT and the SmartImpact project (URBACT), and then in dialogue with private stakeholders look into opportunities for collaboration and business models that respect principles of data integrity. For the local government it might be good to start with establishing principles for how to govern urban data, building on results from URBACT and the SmartImpact project (URBACT), and then in dialogue with private stakeholders look into opportunities for collaboration and business models that respect principles of data integrity.

The third issue is the use standard formats for the data which can enable interoperability and guarantee data quality. Local authorities have an important role to play to address this challenge promoting the adoption of data standards that can facilitate and simplify the exchange and use of data between different data parties.

The fourth issue brings together matters of accessibility and involvement and has to do with establishing the right governance mechanisms that enable a fair, ethical and inclusive data management and use.
The fifth is implementing the right frameworks and standards for security and maintaining them over time, especially in a time where less data will be stored in data centres, and more will ‘at the edge’.

### 4.13 Data-driven innovation

There is also a clear link between practices on data collection and use with innovation practices. The OECD study shows that “The use of data to enable policy work was the most clearly correlated with a city’s familiarity with innovation work of all the variables considered in the survey”. (Observatory of Public Sector Innovation, 2017) The result stresses the link between data collection and use, with innovation capacity and practices, and so give a direction for cities that have needs to transform their mobility systems to organise for both data collection and innovation.

Data relevant for mobility system transformation available inside the city administration is sitting in different departments. Data sources outside city administration is spread among very different stakeholders. It is obvious a local city government need to have a strategy for urban mobility data that include working cross-silo internally and in collaboration with external stakeholders. It also seems reasonable that such a strategy should be closely linked to some function responsible for innovation within the city administration.

Doing that, the data from the pandemic period will be interesting as a “stress test” for urban mobility, and the changes that might be sustained will be important as direction indications for a future system. The analysis should also look for early signs of new stakeholders entering the urban mobility ecosystem.

### 4.14 How cities finance innovative actions on mobility

Work with innovation requires resources. When it comes to financing the work the status of financing the responding cities seem to be weak. Options “no financing” or “don’t know” make up for almost two thirds of responses. For the rest project financing is mentioned by some cities, while only one has a city-level budget for innovation. As the dominant part of innovation work according to responses is done in the different departments, it is surprising no city indicate the option of budget resources in relevant departments.

---

7 Data at the edge is highly distributed; data for any one application can be spread across dozens or even thousands of sites or nodes. Systems for data management remove this complexity, giving developers and operators a holistic view of their data even when it spans multiple sites (SEAGATE, 2019)
If we make a comparison with the earlier mentioned OECD study, out of 89 surveyed cities, 70 reported having specific funding available at the municipality level to support innovation capacity. This could, again, indicate that our responding group have a low maturity for working with innovation, and so don’t set aside relevant financial resources for it.

On the other hand, the answers to how new actions were financed, gives a more positive view on the cities’ ability to find resources in a situation that requires financing of new measures. The responses indicate local government financing is completely dominating in the short perspective but planning for external funding is starting to happen which is a good sign as private financing will be a very important source for handling mobility challenges onwards. Thus, public and private partnerships are expected to have a strong impact in the long-term implementation strategies.
How are the new actions financed?

<table>
<thead>
<tr>
<th>Option</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resources were available in mobility budget</td>
<td>31%</td>
</tr>
<tr>
<td>External financing was (or will be) applied for</td>
<td>31%</td>
</tr>
<tr>
<td>Resources were re-allocated within existing mobility budget</td>
<td>23%</td>
</tr>
<tr>
<td>New resources were made available from other parts of the budget</td>
<td>15%</td>
</tr>
<tr>
<td>External stakeholders are financing part of the actions</td>
<td>0%</td>
</tr>
<tr>
<td>Actions are financed through innovative business models</td>
<td>0%</td>
</tr>
</tbody>
</table>

Figure 25 - Survey Results from Question: How are the new actions being financed?

Notably no financing from the private sector or through innovative business models are mentioned.

The Emergency Governance for Cities and Regions initiative (London School of Economics and Political Science, 2020), shows cities and regional governments report a particular need for more insights on finance and resources, making this a top priority (while at the same time it is a field a low number of cities report using highly innovative practices) (London School of Economics and Political Science, 2020). This indicates a clear gap to address for cities and regions together with financing stakeholders. Unfortunately, this is also the field where there is very little information available in the report’s surveyed online resources. It shows a mismatch between information needs and examples of innovative practices which is “particularly severe for the areas of finance and resources; public participation and inclusion; coordination and integration across government units; cooperation and collaboration across key stakeholders; and communication and consultation.”

In the mentioned OECD study, where around 40% of cities indicated using external funding sources, only a small extent came from private funding.

“Both on innovation and financing of urban mobility, local government need to understand the impact that private sector will have. So, think long-term, work with public-private-partnerships, and measure the impact.”

Daniel Serra, Innovation Hub South Director, EIT Urban Mobility

As cities plan to meet the requirements of a future-proof mobility system, there will be needed to increase private funding substantially. There is extensive work going on in this field, initiated both from European Commission initiatives within different programs (CIVITAS, 2013), and as direct dialogue and work with the financial community. Many new stakeholders, new financial instruments and good practice are becoming
available to scale private financing for cities (for examples and inspiration see for example (Cities Climate Finance Leadership Alliance, 2020) (City Climate Finance Gap Fund, 2020)).

As implementing innovative measures on mobility is depending on all these fields it seems evident that cities need to consider how to organise their work on future mobility strategies, in order to build innovative cross-silo internal collaboration, create external innovative partnerships and find new financing opportunities. As implementing innovative measures on mobility is depending on all these fields it seems evident that cities need to consider how to organise their work on future mobility strategies, in order to build innovative cross-silo internal collaboration, create external innovative partnerships and find new financing opportunities.

4.15 Discussion

According to the formerly exposed in this chapter, it is possible to find a logical discussion with its key findings:

1. Urban mobility is a system with a diversity of stakeholders with different knowledge, roles and responsibility that need to collaborate – no one can steer the system by own mandate or decisions. It constitutes a wicked problem, so collaboration is necessary. Fortunately, there is a lot of knowledge and best practice available in this field.

2. Mobility, and the requirements on future mobility systems, is changing rapidly from the effects of climate change, technical development and digitalisation etc. New stakeholders are entering the playing field.

3. COVID-19 adds new requirements and complexity to the change process, at the same time as the need for speed increases further.

4. For planning and investments in urban mobility, climate change, technological development, new stakeholders and COVID-19 all hold challenges and risks.

5. The large investments needed in future-proof mobility systems, and the large amount of capital becoming available for those investments with new EU programs make it increasingly important to handle both challenges and risks.

6. To analyse and plan for this a broader group of stakeholders, new knowledge and new skills are needed, as well as more data and new ways to organise work in collaboration between stakeholders. This includes engaging with the financial community.

7. Within local government readiness to meet this development vary on a scale from not using data to well organised data collection and use, from lack of innovation work to advanced innovation practices, from only using only traditional internal municipality financing resources to innovative public-private-partnerships and new business models.

8. Organisationally cities span from traditional internal siloed work practices to dedicated cross-silo teams and strong collaboration with external stakeholders. This depend on size and resources of the city as well as on how advanced local government are in preparing for the transition needed.

9. Cities need to move up this “maturity scale” in order to meet the future requirements on urban mobility systems. So, they need new competencies linked to transformation – process design, public-private-partnerships, governance of data, new business models, collaboration methods and tools, innovation leadership etc. Building this will take time, getting it done requires high level political support and financing.
10. With best practices to be found, and new financing coming, there is an opportunity for European cities to start transforming their urban mobility systems as soon as the COVID-19 crisis loosens the grip on their future planning capacity.

Building on the latter the following recommendations are made:

For local governments:

- According to your resources, try to move up the “maturity scale” on organising for innovation and data-driven decision making (see point 7-9 above).
- Identify a broader set of relevant stakeholders and collaborate with them to implement new mobility strategies and solutions.
- Learn from global experiences and best practice but adapt them to your local context. Analyse the playing field for collaboration, and where different methods for collaboration apply.
- Learn from best practice, but adapt to local context.
- Follow the quickly emerging landscape of financial stakeholders and instruments that can contribute in shaping projects and investment strategies for future-proof urban mobility.

For policymakers and funding programs on national and EU level:

- Put emphasis on urban mobility as this is a key area for climate, liveability and societal functionality, and include a broad set of future requirements on urban mobility systems in program setup, financing mechanisms and policy development.
- Provide support for cities to organise for innovation and collaboration – both internally and with external stakeholders. Additionally, support the collection and utilization of data aiming at the transformation of cities’ mobility systems.
- Provide support in terms of models, tools and mechanisms for scaling and spreading best practice in urban mobility to all cities - despite their size and maturity level.

For mobility service providers:

- Align your services with the local government’s goals for the future mobility system.
- Open up for a structured collaboration with local government and learn how you can contribute to the mobility system’s improvement, finding a working business model within that frame.
5 Chapter: Economic impact of COVID-19 – Looking Forward

In this chapter, the focus will be on how the mobility marketplace can potentially look like when the pandemic ends. However, a word of warning is in order, as any reader looking for a clear-cut prediction on how the current situation will unfold for any of the many transport service providers participating in the mobility marketplace will be disappointed. As economists confronted with most questions, the answer will always be: It depends. It cannot be looked into a crystal ball to know what will happen in the coming years. However, it is aimed to offer a conceptual analysis that is elaborate enough to guide practitioners, policymakers, and industry stakeholders on which are the potential effects of the pandemic mid-to-long term, which behavioural changes they should be paying attention to and how they can affect the mobility market.

It begins by providing an overview of the forces shaping consumers’ mid-to-long-term decisions. It is drawn on available evidence on how the pandemic has affected the balance between these forces, and how this translates into an altered scheme of incentives that are expected to lead to certain behavioural trends. These observations suggest a tension between these forces, making outcomes differ depending on the persistence of the effects of the pandemic on their balance.

Then, it is reviewed how the pandemic has affected different transport service providers in the mobility marketplace. Based on our desk research on the impact of the changes in mobility patterns and consumer trends described in earlier chapters, the economic effects are described for each of them. It is pointed out potential future effects that need to be considered based on the early-evidence collected and the altered incentive scheme described before.

Finally, it is provided a first qualitative evaluation of the measures delivered as part of cities’ crisis response, by exploring and assessing the effects the mobility transformation could have on the rest of the economy and the transport system.

It is hoped that readers will be encouraged to use the presented framework to self-evaluate their specific situation and that they can take out some of the recommendations given for the different scenarios. Readers will be able to use this horizon scanning exercise as a tool to be better prepared to navigate the challenges introduced by the pandemic to achieve their policy goals.
5.1 The forces shaping urban form and mobility patterns

This section provides a pre-pandemic overview of the forces that have shaped consumers’ mid-to-long-term decisions. It is done so by focusing on urban economics theory and available empirical evidence to highlight the pre-pandemic balance between such forces. Drawing on early evidence it will be discussed how the pandemic has changed the balance between these forces and how this translates into potentially new behavioural trends that will affect mobility patterns. This section offers a tentative glimpse into urban areas’ future depending on the persistence of the new incentives scheme introduced by the pandemic, laying the base for better detection of the current trade-offs faced by consumers and tipping points or triggers for their behavioural changes.

5.1.1 Available evidence: A pre-pandemic overview

Cities are the greatest human invention, allowing for the elimination of physical space between people and economic agents. Cities reduce the friction created by time and space on our ability to cover our needs and share ideas (Glaeser E., 2011). As with any dynamic system, cities evolve depending on the relative intensity of the demand for physical connection, closeness, or density. Therefore, to understand the challenges posed by the pandemic to the mobility market, it is important to first address how this demand for density arises and which is the role of transportation costs in it. In this section, it is provided a general overview of the forces shaping urban form and mobility patterns.

Transportation is an intermediate good, meaning that it is consumed just as a means to reach a given destination from a certain origin. The activity that brings utility to the consumers is the one carried out at their destination, and transportation is just a means to reach that. Therefore, the mobility market is conditional on all other consumption decisions, and especially on how the city layout is affected by households and firms’ location decisions that in turn end up determining transportation patterns.

Cities experience both push and pull forces that drive different activities closer or farther away from their central locations. If the focus is on firms, increasing returns to scale in the production of certain goods will create larger firms and promote job concentration. This also happens due to the competitive advantage derived from being physically close to other economic agents (agglomeration economies). To understand why this is the case, it is easy to think about how in larger labour markets it is easier to find specialized workers, promoting better matchings between firms and needed skillsets. It can also reduce the cost of inputs supplied by close-by firms, enjoying a larger variety of suppliers and lower prices due to increased competition. Technological agglomeration economies also arise because of employment concentration due to productivity gains and the easier spread of ideas and innovations, and more competition in the labour market.

These positive agglomeration effects in production are partially offset by negative agglomeration economies on non-work consumption due to congestion effects and other negative externalities (like higher pollution levels). In this regard, transportation costs act as a mediating force in this influencing firms’ location decisions, which try to minimize transportation costs conditional on where the production inputs and consumers are located. Note that such location decisions are passed on through the supply chain, affecting the location decision of other firms involved in it. For instance, industrial sectors where scale
economies in production dominate transportation costs will tend towards centralized production instead of a location closer to their customers.

These push and pull forces do appear too on the households’ side of the equation. Households choose their location based on their housing consumption, consumption of all other goods, and transportation costs based on their preferences and budget constraints. This generally implies a trade-off between floor space and commuting costs. Housing prices tend to be higher in central locations (higher demand) making real estate actors build smaller apartments in taller buildings, while suburban locations tend to be cheaper per square meter but offer bigger housing options. Getting access to more floor space is at the expense of experiencing higher commuting costs to central locations (if jobs are concentrated there). Transportation costs do have an impact on households’ demand for housing, a pull factor towards high job density locations; while cheaper floor space pushes households towards the suburbs.

It is important to recognize that shocks in transportation costs are transferred to the real estate market, and shocks in the real estate market are reflected in mobility patterns changes. An example of that is the fact that housing prices decay from the city centre is modulated by highway or train infrastructure accessibility, with higher prices around high accessibility spots. Another example is the fact that households depending on lower speed transportation modes (like public transit) tend to locate closer to the city centre (where it is more accessible), while car usage is more dominant in the suburbs; meaning that workers spatially sort out on their preferences for transportation modes.

This same sorting phenomenon applies to income groups. The relative locations of the rich and poor population groups depend on the relative strength of two forces: (i) consumers’ desire to rent apartments at a low floor space price (pushing the rich towards the suburbs due to their higher-income elasticity of housing demand); and (ii) the time costs of commuting (with the rich pulled towards central locations due to higher income elasticity of marginal commuting cost). If the effect of a higher value of time for the rich group is higher than the lower price per floor space, the gentrification of central locations should be expected and poor subgroups will be displaced to suburban locations (Wheaton, 1977).

However, these location patterns depend on whether each group can afford access to faster transportation mode. If it is too expensive for the poor, richer workers will locate in the suburbs taking advantage of lower prices. On the contrary, all groups being able to afford might bid up suburban housing prices making central locations more attractive to the rich (LeRoy & Sonstelie, 1983).

The interaction between transportation costs and the real estate market is also reflected in the ‘wage gradient’ that exists between jobs at central locations and others farther away, as workers residing nearer to dispersed employment need less compensation for their commuting costs and firms face a trade-off between agglomeration effects and lower wages and rents.

In the last half of the century, transportation costs shrunk and made production location footloose. Services gained importance in the economy and cities became much more innovation-oriented. The dominating pulling force was agglomeration economies driven by knowledge spillovers and higher demand for skilled labour. However, in the last decades, it has been recognized that cities offered positive agglomeration benefits not only in production but in consumption too due to urban amenities. This gave birth to the ‘consumer city’, no longer seen as just production centres but pleasant places to live for wealthy and
educated populations that enjoy a large variety of services and access to goods, public services and are easy to reach (due to higher densities).

Evidence shows that both firms and workers earn more in cities, but workers experience higher rents, tend to experience longer commuting times, and face other negative externalities like higher pollution levels. This suggests that workers are willing to pay a high-amenity premium, and the quality of life will get an increasingly critical factor in determining the attractiveness of particular areas. This is supported by the fact that reverse commuting (trips from downtown to the suburbs) has increased its share in urban mobility. Moreover, high-amenity cities are the ones experiencing larger population growths, and rents tended to increase at higher rates than wages which suggests that those are amenity driven rather than productivity-driven. On top of that, cities tended to experience gentrification processes in downtowns with wealthy residents sorting in specific neighbourhoods (Glaeser, Kolko, & Saiz, 2001).

Additionally, looking at commuting patterns there tends to be a sizeable deviation from the cost-minimizing residence location. This suggests that residents have preferences for certain neighbourhood based on local amenities, location decisions in multiple-workers households have trickier optimization settings, and workers might try to keep their residence close to main job centres to insure themselves against job uncertainty (Hamilton, 1982; White, 1988; Ma & Banister, 2006).

This amenity effect does also mediate in workers’ trade-off housing prices and commuting costs. If it is taken into account that income determines both the demand for housing floor space and amenities (Van Duijn & Rouwendal, 2013). This implies that central locations concentrating more jobs and having strong amenity advantages than the suburbs will comparatively attract wealthier residents. If such advantages become neutral or even negative, will imply wealthier residents will move to the suburbs. So far, empirical evidence suggests a positive (but small) effect of income on commuting distance in the short-run (Van Ommeren, Rietveld, & Nijkamp, 1999; Simonsohn, 2006), but negative in high amenity cities (Gutiérrez-Puigarnau, Mulalic, & Van Ommeren, 2016).

These processes are dynamic, modified depending on the relative strength of the described push and pull forces. For many decades wealthy residents lived in the suburbs and poor subgroups crammed in distressed urban neighbourhood or rural areas. Cheap transportation and car-oriented infrastructure played a key role in the suburbanization process, allowing them to reach farther central locations in a short time. Congestion built up initially putting a halt on that, but negative environmental effects experienced in central locations still made suburban living attractive. Deindustrialization and post-industrialism changed the relative strength of push and pull factors, making agglomeration economies much more preponderant and promoting the back-to-the city gentrifying movement. Especially in the last decades, the upsurge in housing prices has pushed working and middle-class out of the most desirable locations, increasing economic inequality in urban areas.

Current urban form patterns are complex, offering a patchwork of concentrated high-income and low-income sectors, that seem to be driven by the locational decisions of the wealthier groups (as they can easily outbid and displace poorer residents through housing price increases). Wealthier groups tend to locate in the most desirable places (economically functional, aesthetic, and high in natural and urban-amenities), while the less advantaged groups are relegated to inner-city disadvantaged areas, fringe zones, or urban periphery (Florida & Adler, 2018).
5.1.2 How is the pandemic affecting the equilibrium between these forces?

The pandemic has exponentially increased the agglomeration negative effects of cities, with physical proximity to others becoming a threat rather than an advantage (risk of infection). Moreover, social distancing measures make it difficult to exploit agglomeration economies and enjoy urban amenities associated with dense cities, greatly reducing the intensity of the positive agglomeration effects. This is a fundamental change in the equilibrium between the push and pull forces, which might trigger households and firms’ behaviour changes that then affect urban form and mobility patterns.

The following subsections provide preliminary evidence on how the pandemic is affecting such interactions.

5.1.2.1 Economic crisis, job losses, and public sector financial deficits

Job losses due to the economic crisis associated with the pandemic are not homogeneously distributed across economic sectors and social groups, with marked differences along the digital divide. The impact on each sector is inversely proportional to telecommuting feasibility. In this regard, small businesses, restaurants, retail, personal services, and arts and culture are the ones that received the major hit. Closure of these types of activities highly reduces the economic vitality of urban areas heavily reducing the level of urban amenities. Additionally, the impact borne by each social group does also reflect these economic sector disparities. Low skilled labour tends to work in the most affected sectors while high-income workers often have no problem to telecommute. This implies that low-income groups will be the ones facing larger income reductions potentially triggering residential relocations towards more affordable neighbourhood.

The economic crisis will also mean that local governments will face fiscal deficits, as they are the frontline of the crisis response, implying large expenditure increase (i.e.: health protection equipment, lockdown implementation, or social support to the most vulnerable) and a drop in fiscal revenue (CEMR, 2020). Even with the provision of extraordinary funds by national governments and the European Commission, the fiscal deficits will likely hinder the provision of public goods with a double effect on the magnitude of the forces discussed before. On the one hand, cuts in public services provision can reduce the positive amenity effect in certain urban areas; while on the other, potential cuts in public transit provision will reduce accessibility and increase transportation costs in certain areas (higher pressure for such cuts will most likely concentrate in less well-served areas already showing lower demand levels).

This issue is of specific relevance for the mobility market when it refers to public transit provision, as the pandemic has been a hard hit to two out of three of the core economic reasons that justify transit subsidies. First, it has greatly diminished economies of scale in public transit provision that arise from high fixed costs (train tracks, stations, and vehicles) and very low marginal costs (associated to high capacity). This makes the marginal social costs to be below average provision cost, imposing the need for a subsidy if transit fees are set optimally (equal to the marginal social cost each trip induces). The need for social distancing renders most of public transit capacity useless, due to imposed restrictions. Second, the pandemic also limits the economies of scale that arise on the user side by reducing the ability of transport service providers to exploit the positive external effects of increased ridership, what is known as the Mohring effect (Mohring, 1972). This is because more riders imply additional services, and these in turn reduce the average time cost for riders and the average operating cost for the transit operator, which the transit subsidy internalizes.
It is important to stress that many cities imposed capacity reductions to ensure social distancing, but if such low occupancy rates are ought to be maintained it creates the need to increase transit subsidies and expand current fleets. An example of this is shown in (Basso, Sepúlveda, & Silva, 2020), studying the case of Santiago de Chile. They found that keeping the bus network capacity to 66% of pre-pandemic levels (distance between passengers just 0.5 meters) will entail a more than twofold subsidy increase (if the fee is kept unchanged) and a need to expand the fleet by 40% unless a set of policies are simultaneously implemented – including priority lanes, staggered work shifts, and substantial reduction of trips. Additionally, they point out that reaching a 1m social distance seems unfeasible (even with the additional policies in place).

On the other hand, the pandemic and associated potential modal shift do make more relevant the role of public transit subsidies for the correction of unpriced external effects of car traffic. Available evidence suggests that the congestion relief effect of public transit is quite sizeable and can almost alone compensate for the transit subsidy in travel time saving for road users and other externalities (Anderson, 2014); (Adler & van Ommeren, 2016); (Bauernschuster, Hener, & Rainer, 2017). However, all these conclusions rely on transit pre-pandemic ridership figures. Social distancing measures reducing its effective capacity and making riders use alternative transportation modes can even eliminate transit ‘greener’ advantage, as its emission benefits crucially depend on ridership (Sui, et al., 2020).

In any case, it is important to highlight that transport subsidies can also distort land use decisions, and be used to improve the allocation of labour easing the gap between job and residence location. This is especially relevant for low-income groups even if transport subsidies just allow to recover a fraction of the welfare loss due to spatial mismatch (Zenou, 2000): (Martin, 2001).

5.1.2.2 Telecommuting, the housing market, and employment relocation

Chapter 2 already showed that the lockdown hugely increased telecommuting levels, yet it is not clear to which extent this temporary burst will be persistent in our labour markets. It has already been reported that telecommute can heavily affect lockdown economic consequences across places, mainly driven by disparities in terms of the compatibility of jobs with such work modality. This can be seen at a national level where high-income economies have around 40-50% potential for the share of remote-work-compatible jobs, while figures move around 20-30% for developed countries (Ozguzel, Veneri, & Ahrend, 2020) and 5-15% for developing ones (Sautiel, 2020). These differences in telecommuting potential present city and industry-level dimensions, where high-skill and high-wage jobs can be done remotely up to 80-90% and low-skill/wage jobs are non-compatible (Dingel & Neiman, 2020). Once the potentiality for telecommuting is confronted with feasibility constraints, these figures are reported to be slightly lower when observing how many jobs were conducted remotely during the COVID-19 crisis (Bartik, Cullen, Glaeser, Luca, & Stanton, 2020). The average remote work during the first wave in the US was 20-30%, with huge disparities across industries (64% of the high-education to 34% low-education firms switched to telecommuting).

To measure how much of this telecommuting will persist long-term it is key to assess its potential effects on productivity, working conditions, potential career opportunities deterioration, and work-life balance. In this regard, preliminary evidence suggests that both companies and workers have not perceived productivity reductions, and even a large group pointing towards at least short-term gains. When firms have been surveyed on their expectations about whether these exceptional work arrangements will be
continued about 40% of them will keep their workforce telecommuting (Bartik, Cullen, Glaeser, Luca, & Stanton, 2020). When workers were asked if they would like to keep telecommuting often or all the time, about 88% of them answered they would do so (Felstead & Reuschke, 2020). Similarly, on a global survey conducted by (IBM, 2020) about 75% of respondents reported to be willing to continue to work remotely, with 54% willing to make it their primary way of working; even just 41% of CEOs surveyed felt people have the skills and resources to properly do so.

Moreover, some studies suggest that telecommuting has no adverse effect on career advancement prospects neither affects job performance evaluations for workers doing it on a part-time basis, where the relationship with co-workers is only harmed for those doing it more frequently (McCloskey & Igbaria, 2003); (Gajendran & Harrison, 2007). These studies also tend to report telecommuting as mainly beneficial through increased autonomy, better work-life balance, and increasing job satisfaction. Yet, the intensity of the threats to telecommuting broad adoption arises from the work culture, managerial attitudes, and human resources policy specifics in each company. Remote working can impede visibility and requires changes in the way the relationship with colleagues/clients is conducted to enhance career opportunities through professional networks, where face-to-face still offers higher advantages (Richardson & Kelliher, 2015).

Regardless of the specific figures telecommuting reaches after the pandemic, what is important to highlight is the incentives it introduces for households and firms, and its impact on urban form and the mobility marketplace. Telecommuting acts as a facilitator for land-use changes, as it leads to a significant reduction in transportation costs that increases workers’ disposable income. In this case, this implies that workers would be able to afford longer (less frequent) commutes and enjoy higher utility levels by increasing their housing consumption at locations farther away from their job places (with cheaper housing prices). This will make central locations comparatively less attractive.

Available evidence suggests that the net impact of telecommuting on households choosing to relocate and the associated changes in car usage are heavily dependent on the relative intensity of the forces described above. Some authors found that telecommuting was associated with moves away from central locations with just a small percentage of remote workers in short-term study frameworks, and so a net reduction in distance travelled is positive (Nilles, 1991). However, recent theoretical models and empirical evidence tend to suggest the opposite, claiming relevant urban sprawl and increased negative externalities in the long run because telecommuters choose to commute longer distances (and travel durations) compared to non-telecommuters, also potentially transferring it to non-work trips and using more polluting transport modes (Zhu P., 2012); (Kim S. N., 2017); (de Abreu e Silva & Melo, 2018). In any case, no clear cut answer is yet available, as the net effect crucially depends on the combination of two opposing effects of telecommuting: (i) the relocation effect (workers changing their residence), and (ii) the substitution effect (the exact replacement of on-site work for remote work). In other words, the effect depends on the combination of the increase in distance travelled and the frequency of commute trips (Lund & Mokhtarian, 1994); (Kim S. W., 1997); (Rhee, 2008).

(Su & Liu, 2020) provide early evidence of these changes in the housing market during the pandemic. They find a more pronounced decline in the demand for housing in cities and neighbourhood with higher population density in the US, with no significant difference in new listings. This drop in home sales seems to be larger in neighbourhoods with more telecommute-compatible jobs around, where housing prices were higher pre-pandemic, and with plenty of consumption amenities. This suggests the home buyers'
potential change in preferences, at least temporarily. Whether this is a tipping point for the past trend in residents flocking into central locations will depend on how long the relative strength of the forces shaping consumers’ choices is disrupted by the pandemic. Housing is a durable good, and its purchase is only considered during a certain time window. Those confronted with the current set of incentives are the ones for whom residence location choice will be affected. Most attractive municipalities near large cities, with high amenity levels, will likely face most of this relocation pressure.

Urban planners should consider this to prevent the negative effects on housing and transport markets at a metropolitan and regional level, also taking into account the potential contribution of telecommuting to congestion and reduction in agglomeration effects at central locations, which might be an additional argument for the introduction of congestion charging or other policies (Safirova, 2002). The changes induced by the pandemic will also impose the need to reconsider current land-use policies (like building height or density restrictions, and zoning) to reduce frictions to desired urban form changes and ameliorate the undesired ones.

Likewise, the previously described incentives also apply to firms (Tayyaran & Khan, 2003). If their workforce is not constrained to reach their job place as often, this expands the firms’ potential labour pool and alleviates locational proximity constraints. This can either pull firms towards central locations with higher exogenous productivity due to agglomeration effects or push them away to less central areas to access lower rents and take advantage of the lower need to compensate their workers for commuting costs (exploiting the wage gradient). This will most likely depend on their dependence on agglomeration effects, which is industry-dependent. Additionally, households demand shifts towards peripheral locations and its reduction at central locations will affect real estate prices. This is expected to create a cost incentive for firms to relocate in the opposite direction, which is further spurred by the higher cost-efficiency of central locations thanks to the saving in floor space induced by telecommuting. Additionally, this does also give companies facing higher real estate costs and high wage labour, would probably be the ones pursuing more telecommuting adoption. Available preliminary evidence using theoretical models seems to suggest that job centralization (or some sort of polycentrism) seems a plausible result if no offsetting congestion effect on commuting times appears (Delventhal, Kwon, & Parkhomenko, 2020); (Lennox, 2020).

Additionally, it is important to recall the previously stated differences in the ability to telecommute between social groups which do also translate into spatially differentiated relocation patterns affecting commuting patterns by transportation modes, depending on the relative dependence of each group to different transport modes. From the analysis of previous issues, it is important that planners give special consideration to the potential effects of telecommuting in the design of their policy response to keep the benefits it entails and limit its potential caveats. As pointed out by (Handy & Mokhtarian, 1995), changes induced by telecommuting must not occur in a car-dependent scenario. The design of flexible land use policies coordinated at a regional level can be crucial to help steer potential relocations away from car-dependent neighbourhoods.

5.1.2.3 Equity considerations and spatial mismatch

Many have been quick to blame cities' density for virus dispersion, but rather than a density issue now evidence suggests that outbreaks’ severity is more related to structural economic and social conditions (Hamidi, Sabouri, & Ewing, 2020), and policy response (Bel, Gasulla, & Mazaira-Font, 2020). Cities with a
high concentration of poor residents and inadequate housing conditions are more vulnerable than those with better resources. Thus, rather than density, it is more an overcrowding issue. This, and the lower likelihood of low-income groups being able to telecommute, make them more exposed to infection.

These equity considerations are also relevant to the equilibrium of the forces driving urban form and mobility patterns. In many cities, less favoured income groups already tend to experience longer commutes, due to just being able to afford housing located in low-amenity areas with fewer job opportunities – generating a spatial mismatch between jobs and residence location. They are also more reliant on public transit, so cuts in this service can further shrink their accessibility to such opportunities (Gobillon, Selod, & Zenou, 2007). The gender differences in time constraints due to childcare duties, is also relevant for job and residence location decisions, with women (even high-skilled) choosing jobs closer to their residence and potentially benefiting the most from broader adoption of more flexible work schemes introduced due to the pandemic (Wheatley, 2013); (Le Barbanchon, Rathelot, & Roulet, 2020). On the other hand, high-income workers seem to be less and less limited by constraints on employment location, so this makes them able to relocate more easily to high-amenity outer urban areas or close by municipalities. To tackle these disparities that can aggravate spatial mismatch triggered by the new set of incentives introduced by the pandemic, policies to lower low-income housing market frictions and mobility strategies should be considered.

5.1.2.4 Retail

The rich variety of consumer goods and services offered by the retail sector is one of the main advantages of urban living. Shops tend to cluster together in certain streets or districts due to the positive externalities they impose on each other, as the close location between them allows customers to visit several shops in a single trip reducing both transportation and search costs. Available evidence shows that shop rents positively depend on footfall and the number of shops closes by, while vacancies are negatively related to the former (Koster, Pasidis, & van Ommeren, 2019). For example, shopping areas in the Netherlands show an average rent gradient of -15% per 100-meter distance away from their centre, with a flatter decay rate when attractive complementary amenities are present (Teulings, Ossokina, & Svitak, 2017). This is just another expression of the positive agglomeration effect already highlighted in previous sections.

However, brick-and-mortar retail was in a pre-pandemic downward trend, driven by the shift to e-commerce, the abundance of shopping malls, and the shift in consumer spending towards the experience-economy. The pandemic has accelerated some of these changes. Using credit card transactions data between October 2019 and March 2020 across the 16 cities, (Relihan, Ward, Wheat, & Farrell, 2020) show that consumers’ spending decreased on “commerce” by 12.8% between March 2019 and March 2020, with the decrease being most severe in low-income neighbourhoods. Even overall spending decline, consumers shifted their purchases towards online commerce by 4.6 percentage points, where grocery and pharmacy spending experienced extraordinary rates of growth. Low-income neighbourhoods were the ones increasing less their online spending and are reported to buy farther away from where they live.

---

8 Their definition of “local commerce” includes spending on: clothing, grocery, fuel, general goods, home maintenance goods and services, local leisure goods and services related to arts and sporting activities, pharmacy, personal care and professional consumer services, restaurants, and local private transport and public transit.
Moreover, (Bartik, et al., 2020) reports a large amount of business temporarily closing and laying off a proportional number of workers. The financial fragility of many of these businesses, combined with the severity of social distancing measures, is affecting the expectation of survival for a large number of firms. Focusing on US businesses, they show that conditional on the duration of the crisis it can bring the percentage of them expecting to reopen from 70% (one month) to just 40% (four months), except groceries. Similarly, some evidence suggests that the previous patterns are being repeated in the current pandemic, with about 75% of the consumers surveyed still shopping local for essential goods (IBM, 2020). Evidence from credit and debit card transactions suggests that despite its small relative market role on-line grocery has experienced an unprecedented increase, jointly with the big demand shift to e-commerce (see Figure 26).

![Figure 26. Change in consumers' credit and debit card spending from 2019 for the week ending April 1. Circle diameter determines the size of the market (Source: (Leatherby & Gelles, 2020))](image)

Such effect is not new, as the substitution effect between e-commerce and brick-and-mortar retail has been shown before for other airborne virus outbreaks, where additionally consumers can decide to delay purchases for certain types of durable goods but tend to not significantly change how locally they purchase groceries and essential goods (Jung, Park, Hong, & Hyun, 2016); (Jung & Sung, 2017).

This imposes a major threat to urban retail, as major closings can lead to a potential blight if a critical mass of shops cannot be sustained. This means they can attract fewer customers to visit the area due to lower positive externalities. Which, in turn, has implications on the attractiveness of certain areas (loss of the amenity effect), location decision (mid/long-term), and mobility patterns. A high number of vacancies increase the pressure from competing land uses (especially residence). For a long time, local governments have been intervening through implicit subsidies to the retail sector, with investments in amenities in the public space (like pedestrian areas or free parking) disregarding the potential effects on other markets (mainly transport and housing). Current circumstances offer a good opportunity to rethink how to intervene to promote liveable areas and support the needs of the different social groups.
5.2 Impact assessment of COVID-19 in the mobility marketplace

In this section, it is reviewed how the pandemic has affected different transport service providers in the mobility marketplace. Based on our desk research on the impact of the changes in mobility patterns and consumer behaviour trends described in earlier chapters, it is described the economic effects for each of them and point out potential future effects that need to be considered.

5.2.1 Implications for public transit

The 2 Chapter already discussed the heavy toll that social distancing measures take on transit ridership. Here it is delved into its origins and economic implications. Uncertainty about the total number of trips consumers will take each month (due to social distancing restrictions coupled with telecommuting) and the travel mode more convenient for them can make transit passes unattractive for travellers. One should expect transit riders to switch to more flexible multi-ticket options that allow them to reduce out-of-pocket expenses even at the expense of purchasing each trip at a higher unitary price, as initial evidence seems to support (Jenelius & Cebecauer, 2020); (BCG, 2020). Additionally, short period tickets aimed at tourists and other non-regular users plummeted, reducing transit operators' revenues and making the service more dedicatory due to its higher relative contribution to cost recovery (per trip). This stresses the need to rethink fare structures for the future, where a regular transit use might not look that regular anymore, to avoid introducing an additional disincentive to transit use.

Mobility is shown to be highly correlated to COVID-19 outbreaks (and deaths), supporting the need for social distancing measures that specifically target its reduction to stop the virus spread with capacity reductions or other supply restrictions (Badr, et al., 2020); (Harris, 2020); (Knittel & Ozaltun, 2020); (Muley, Shahin, Dias, & Abdullah, 2020). However, this is very different from claiming that public transit has a major causal role in the virus dispersion, as the use of any transportation mode can be correlated with other unobserved risk-of-exposure factors not accounted for in these studies. Drawing on studies analysing the role of the use of public transit on the risk of infection for COVID-19 and other similarly acute respiratory diseases, it can be seen no conclusive evidence in the scientific literature. Applying different research strategies, some authors show that public transit use increases the risk of infection for airborne diseases (Troko, et al., 2011); (Pestre, et al., 2012); (Mohr, et al., 2012); (Goscé & Johansson, 2018); (Hu, et al., 2020). However, some of these and others show that household and work-related close contacts seem to be the most important exposure factors. Simulation-based analysis suggests that the relative number of cases directly associated with public transit use might be low, with lower or non-significant risk increases for short and long-distance trips (Williams, et al., 2010); (Cooley, et al., 2011); (Castilla, et al., 2013). This is somewhat supported by the current analysis of cluster cases in conjunction with no cases increase coupled to transit reopening, suggesting no super-spreader role of public transit. However, the intrinsic difficulty for contact tracing in public transit settings, the definition of a cluster itself (at least 3 cases), and the current levels of tracking efforts made does not equate any detection of a cluster to no circulation of the virus. Additionally.

---

9 Pieces of criticism to the only study timidly suggesting such relation (Harris, 2020) can be found here and here.

10 Epidemiological authorities tracing down outbreaks in Germany, France and Austria have not associated significant number of outbreaks to public transit use.
a recent study found that places with larger commuting flows exhibited higher mortality levels during the pandemic, but not a significant linkage to transit usage, suggesting mobility and not modal choice could be considered the main contagion driver (Borsati, Nocera, & Percoco, 2020).

There is a huge need for a proper causal study of the role of public transit on the risk of infection to guide proper policy interventions. So far, there seems to be a certain consensus that the risk of infection in public transit use is related to the exposure time (travel time), riders’ behaviour, and use of self-protection measures (silence and masks), crowding, and ventilation conditions. In this regard, simulation-based available evidence suggests that the risk for trips below 30 minutes is relatively low, with compulsory mask and improving ventilation being a good strategy for keeping reproduction numbers in check in public transit (Furuya, 2007); (Zhu, Srebric, Spengler, & Demokritou, 2012); (Xu, McCluskey, & Cressman, 2013).

Transit operators have made big efforts to minimize the risk of infection (with the associated increase in operational costs) ensuring safe travel by: (i) adapting their services, capacity, and schedules; (ii) conducting cleaning and disinfection specific procedures; (iii) conducting efforts to ensure the use of protective equipment by their staff and passengers; (iv) increasing the IT tools to monitor crowding conditions and providing real-time information to users; and (vi) arranging or expanding contactless payment facilities (UITP, 2020). However, regardless of its actual role in the pandemic spread, public sector actions to ensure safe use will be futile if they do not realize the importance of consumers’ perception of their behaviour. People incur behavioural adaptations due to fear of infection, where survey evidence suggests that about 75% of respondents reported avoiding the use of public transit when faced with an epidemic of an infectious disease (Sadique, et al., 2007). Consumers tend to associate public transit with the presence of large numbers of people in relatively enclosed spaces (both in vehicles and stations), which can be dissonant with their perception of proper social distancing.

People are likely to avoid public transport due to the perceived higher risk of contracting the virus that derives from the often-present difficulties in avoiding closeness to other passengers. This is supported by preliminary evidence suggesting that individuals reduced travel to locations perceived as medium or high-risk areas, specifically avoiding public transit (Gerhold, 2020); (Hotle, Murray-Tuite, & Singh, 2020). Based on these surveys they also show differences between gender and age groups regarding risk perception and exposure-reduction behavioural changes, being female and relatively young people the ones more precautious. Additionally, other surveys do also suggest that the risk of infection has jumped to the top of key reasons to choose a specific transportation mode during the pandemic (McKinsey, 2020); (IBM, 2020).

The fact that consumers change their travel behaviour due to fear of infection has been previously described. For instance, (Wang K. Y., 2014) found that each reported new SARS case implied an immediate loss of about 1200 underground ridership in Taipei City during the 2003 outbreak, with the daily loss dissipating at an exponential decay rate until fading out after about 28 days. This translated to 50% of daily ridership loss during the peak of the 2003 SARS outbreak. Similarly, (Kim, Cheon, Choi, Joh, & Lee, 2017) show transit ridership nosediving in Seoul during the MERS outbreak in 2015, with people from different high-income groups and rich neighbourhoods changing their travel patterns substantially more (due to higher lifestyle flexibility).

---

11 Specific behavioral adaptations for COVID-19 are reported in (Balducci, 2020).
Additionally, differences in the perception of the infection risk between above and under-ground transport options can be assumed to exist, as people seem to feel more comfortable using above-ground transit options (Douglas, 2016; Dow, 2016) as they offer less of a concealed travel experience and more chances of good ventilation. This is supported by bus ridership recovering faster than subway figures in some cities, suggesting that transit systems may need to rely more on enhanced bus services. These are good at adapting to demand changes in the city’s economic activity layout; offering good travel times if enough priority is given to them (dedicated lanes).

Moreover, it seems important to highlight the potential institutionalization of the ‘fear to public transit’ during the COVID-19 pandemic, due to governments specifically calling people to avoid using transit while recommending alternative transportation modes (including private vehicles). While they tried to compel citizens to ‘avoid any unnecessary travel’, doing so targeting public transit with special intensity might have made the message come across as ‘avoid public transit’, potentially reinforcing consumers’ risk perception and posing a threat to recovering pre-pandemic ridership numbers once the pandemic is over. Examples of the consequences for the transport systems of such dread behaviour are available from studies focusing on behavioural responses to terrorist attacks (Percoco, 2019), with demand shifting to private vehicle use (bikes, motorbikes, and cars) and increased pollution. This highlights the need to align perceived and actual risks, where the ‘over-reaction’ (police and military deployment) or how information is disseminated (communicative strategy) might be crucial to shaping risk perceptions.

Public transport operators are struggling due to plummeted demand and operational costs increase imposed by social distancing measures. This situation, coupled with the economic crisis and the expected financial deficits, puts current subsidies and fare schemes under heavy pressure. The pandemic has exposed how dysfunctional the governance of the mobility marketplace is, probably better described as a patchwork resulting from a long set of cumulative decisions, where some business models are prioritized by a skewed taxation regime and implicit subsidies (especially private cars). Actions to foster the efficiency and flexibility of transit systems (as part of the ‘build back better’ strategy) calls for a reboot of the governance of transit systems. There is a need to rethink how subsidies are allocated across transport modes (and trips); take actions to mitigate financial risks due to demand shortfalls (UITP, 2020); introduce mechanisms to more dynamically adapt to changing situations; confront the challenges of digitalization and the disruptions introduced by MaaS, trying to integrate newer business models with transit systems on a levelled playing field.

5.2.2 Modal shift towards individual mobility

Walking, cycling and car use have recovered faster than public transit after the reopening (as low perceived infection-risk options). How this shift towards individual mobility settles down will be crucial for cities (and their transport system), as consumers going back to their cars coupled with the need to reclaim public space for other transport modes and social distancing can make the situation worse, increasing congestion and pollution. Concerning evidence on such negative outcomes is already being reported by some cities (Centre for Cities, 2020).

---

12 See New York early figures here and here.
13 Even different State Aid Programs that might be put in place (see an example here).
As described before, telecommuting is expected to favour longer commutes (even less frequent). Longer commutes coupled with higher working hours flexibility can increase the appeal for car usage, as holding everything else equal cars offer more competitive travel times in such a scenario. Using a simulation model accounting for telecommuting and shifts in modal choice preferences calibrated to New York City, (Wang, et al., 2020) suggest that transit ridership will settle around 64% to 73% of pre-pandemic levels depending on how the established transit capacity in the reopening, either 50% or 100% respectively; while traffic levels will ramp up to as much as 140% of pre-pandemic levels (regardless of the transit capacity scenario). Those shifts might not seem initially dramatic, but small deviations in an already heavily congested road network can be disproportionally large due to increased congestion. They also suggest that a big increase will be experimented by bike and bike-sharing services, reaching around 100%-120% and 92%-184% respectively. Their findings suggest that transit capacity restrictions need to be paired with heavy support for micro-mobility options and travel management initiatives to reduce congestion (like congestion charging and parking pricing).

In this sense, there is a need to know whether the pandemic has caused the incentives that make cars more attractive to dilute the efforts made by cities to disincentivize ownership and use. Car appeal has increased during the pandemic, as they offer some ‘insurance’ against contact with other travellers, while low traffic levels during lockdowns allowed for faster travels.

Different surveys coincide in pointing out that between 17% and 40% of respondents intend to use more of their cars, with 25% reporting using it as their exclusive transportation mode going forward (BCG, 2020; IBM, 2020). This is likely to apply to consumers already owning a car, but this can potentially translate into increased car ownership. Available evidence suggests that car purchase intent is on average at around 10%, still below pre-pandemic levels, even it has grown up four percentage points from the beginning of the first wave. It has increased across all regions (with geographical disparities in the magnitude of the increase), but especially among high-income households. Planned expenses are still below pre-pandemic levels but increased from the first wave, with respondents being less focused on electric vehicles except for China. The share of respondents intending to buy irrespective of the available ‘discounts’ also increased since the first wave, making this purchase intent more robust (McKinsey, 2020). Consistent with this, (BCG, 2020) suggests that around 10% of EU respondents report being more likely to buy a car post-lockdown, a percentage that is surprisingly constant across income groups. However, these figures show large geographical disparity with larger for the US and enormous for China, with ranges for high-income low-income groups that go from 30-20% to 80-40% respectively, as shown in Figure 27.

Unfortunately, these studies offer no conclusive evidence on whether the demand for cars will be shifting towards high energy-efficient options (like EVs). (McKinsey, 2020) suggests that consumers’ purchase intentions are now less focused on EVs, while data provided by (IEA, 2020) suggests that the demand for EVs has been less impacted than other car segments due to beneficial traffic regulation, subsidies, or tax reductions, increasing their relative share in the total number of car sales.

---

14 It is important to highlight that their modelling strategy implicitly assumes no changes in, which can make this figures biased if extrapolated outside a strictly very short-run effect.
Figure 27. Changes in purchase intention for different transport options (Source: (BCG, 2020)).

However, this larger appeal of cars does not need to necessarily translate into current car purchase levels. Car sales plummeted during the lockdown, and so did its production. However, low car sales do not necessarily mean a reduction in car ownership, as consumers might keep their cars for longer (with implications for pollution due to lower energy efficiency). Some have reported an increase in sales after lockdowns, probably an expression of pent-up demand (purchases that would have happened anyway) even figures are still below pre-pandemic levels. Cars are durable goods and the second-largest household expenditure after housing, so any major change in these figures will materialize with some lag. Whether car ownership rises or not will boil down to the larger appeal of cars overcoming financial constraints and disincentives implemented by cities. The longer the pandemic lasts, the more likely it is that car ownership increases for social groups with better financial prospects and more flexibility to relocate or change jobs (known car ownership triggers). Cities need to monitor closely the car sales market to anticipate an increase in motorization rates and attenuate its potential negative effects.

Cities should expect an increase in motorbike and scooter ownership, especially those enjoying mild weather conditions, as a convenient alternative to cars due to usually free parking and implying a cheaper investment. Growth in sales and registrations have been reported with the electric segment taking up larger market shares, even total figures might end up below year-to-year comparisons due to current economic uncertainty.

The pandemic also affected diesel and gasoline prices, which are determinants for car ownership and use. An initial drop in demand for petroleum-based products was experienced during the initial phase due to a combination of economic-wide closures and record production levels. This saturated market caused

---

15 Anecdotal evidence for the car sales market bounceback can be found here, here and here.
16 Anecdotal evidence for motorbike and scooter sales increase can be found here, here and here.
production to stockpile and prices to drop abruptly. This was followed by a sharp increase in prices as producers imposed heavy production cuts while demand started to recover. Gasoline demand dropped compared to April 2019, almost fully bouncing back to normal in May when lockdowns were levied. However, this did not translate into gasoline retail prices as firms use a “sticky price strategy” to set prices, making consumer gasoline prices follow a similar but more muted trend (see Error! Reference source not found.).

Figure 28. EU27 weighted average consumer prices of petroleum products net of duties and taxes (Source: constructed from Weekly Oil Bulletin – European Commission data)

Moving forward, the recurrence of outbreaks in many countries have made IEA and OPEC revise downward their demand forecast for next years, expected to be sustained at 2019 levels until 2023. This coincides with other researchers’ analysis and some claim it to be the beginning of the much anticipated “peak oil” (Jefferson, 2020); (Klare, 2020); (Norouzi, de Rubens, Choubanpishehzafar, & Enevoldsen, 2020)). In any case, the role of geopolitical considerations should not be dismissed, especially with how the pandemic plays out for oil-exporting countries. The flatness of the crude production cost curve and oil producers’ cartel agreements offer plenty of room to make this more of a plateau. Additionally, political economy considerations should not be dismissed either. Governments are now trying to focus their policy efforts on alleviating the economic effects, which might potentially not pay as much attention to their side effects on energy transition.

The combination of the high number of jobs conducted on a working-from-home basis and lower gasoline prices can further increase car appeal for consumers. Additionally, lower fuel costs can also disincentivize

When oil prices decrease, retailers delay lowering the selling price due to future market uncertainty. When oil prices increase, they also might hesitate to increase the selling price; a process driven by local competition with neighboring gas stations due to a potential loss of client if the rise is not matched by their competitors. The result of this tends to be higher margins when oil prices fall, and lower margins when oil prices rise. More in depth analysis of such dynamics are described here.

Check news pieces on this here, here, and here.
consumers to switch to more fuel-efficient models, potentially reducing the increase of EVs market share. This suggests that public authorities might need to introduce more stringent travel demand management strategies to compensate for the reduced incentives coming from fuel prices to keep promoting the decarbonisation of the transport sector at the needed pace, as social pressure for cleaner air is only expected to keep building up.

Moving to shared mobility, some argue that an increase in the use of taxis and ride-hailing services should be expected (de Vos, 2020). However, evidence on this is far from clear. As discussed in Chapter 2, ride-hailing services have been affected by reduced mobility due to social distancing measures too, falling behind traffic recovery with drivers cutting back on worked hours to adapt to the reduced demand and focusing on peak periods (Zheng, Zhang, & Nie, 2020). (BCG, 2020) suggests that a similar percentage of respondents report being willing to use more or less this type of services going forward, with much clearer evidence for consumers willing to use their private vehicles. This is further supported by low confidence in these services by users avoiding transit use (Tan & Ma, 2020).

Treating drivers as independent contractors might put transport network companies (TNCs) in a strong position to weather this storm. The taxi sector faces a huge downturn while already losing ground to TNCs (besides where stringent regulation still protects them) and the prices for taxi licenses (medallion) are in decline.19 The aftermath of this is an expected higher concentration in the taxi market.

The change in mobility patterns induced by social distancing measures (like work-from-home) heavily restricted trips to downtowns and forcefully made residents try to cover all their needs on a hyper-local level. This made residents confront how much of a 15-minutes city they live in, implying a heavy drop in median travel distances, as described in Figure 29. In such a scenario, micromobility options are highly competitive to both cars and public transit, with walking and own bike use being the modes consumers report to be willing to lean on more moving forward (BCG, 2020). This suggests that the private part of the micromobility sector will probably get out of the crisis better off than its sharing services counterpart.

19 See more data here
Micromobility options were already in a fast-paced increasing trend. However, bikeshare and e-scooter services experienced a drop in demand during the stay-at-home phase. Several bikeshare systems closed permanently or suspended operations during the pandemic, especially docked systems (USDOT, 2020). Similarly, e-scooter services also pulled out from many cities (laying off a large share of its workers) while travel restrictions were in place, even in some cities they were asked to deploy more vehicles to fill the gap left by reduced transit services. Additionally, where still open micromobility operators experienced increased operational costs due to extra sanitation of vehicles, with some offering protective equipment freely distributed to customers. A process of consolidation should be expected due to the financial situation (already in place before the pandemic), as micromobility start-ups struggle to make sharing services profitable and investors shy away from the sector with venture capital shifting towards less risky investments. Only the largest and best-managed companies will likely be able to weather the storm. This is especially the case for e-scooter services, which were already facing high vehicle maintenance costs and imposing pricey fares, making it convenient just for a restricted demand segment and on an occasional use basis.

Opposite to public transit, bikesharing ridership bounced back rapidly after the reopening with figures showing similar to pre-pandemic levels and even reached higher ones. However, consumers’ concern about hygiene in shared services also has an impact on demand, as just below 10% reported feeling shared services to be safe (McKinsey, 2020). Moreover, their need to rely on a more certain sustainable mobility supply might have pushed them towards bikes and e-scooter ownership (BCG, 2020). In particular, bike sales have skyrocketed during the pandemic even making dealers and manufacturers run out of stock, and so did sales of bike tools and maintenance products to update already owned bikes. This points towards a large increase in bike use promoted by a combination of fear of public transit, increased bike infrastructure, specific subsidies/rebates within stimulus packages, and is a good leisure activity during lockdowns. It is hoped that improved infrastructure might promote bike culture and increase the modal share of bikes by making its use more inclusive, especially for those shifting to this transport mode for the first time.

All this can potentially cause a shrink of the shared micromobility sector, at least until the economic downturn passes. However, a major determinant of how the situation will play out for this sector depends on the regulatory approach taken by cities moving forward. Many cities have taken a belligerent approach to private-initiative shared services due to perceived coexistence problems and unfair use of public space (users’ reckless riding and parking behaviour) and imposed fees on e-scooters, limited fleet size,

---

20 See an example of pre-pandemic micromobility trend here.
21 In example, Voi pulled out from 32 of the 38 cities where it was present (as discussed here), while Spin was asked to deploy more e-scooters (as discussed here).
22 See further evidence on this here, here and here.
23 Vehicles seem to not last long (see here).
24 US bikesharing ridership figures available here, and a Chinese example here.
25 Evidence on bike sales can be found here, here and here.
26 More on this here.
prohibitions to park them within large parts of the city or simply banned them completely.\textsuperscript{27} Such regulations highly limit shared micromobility profitability potential.

The need to reorganize public transit more flexibly and consumers’ shift towards micromobility offers cities a good opportunity to exert stronger efforts to integrate the different travel modes paving the road for Mobility-as-a-Service (MaaS) developments. Several cities had already begun this process before the pandemic. New forms of PPPs need to be explored, potentially using subsidies to incentivize transport operators to adhere to the MaaS scheme and exchange necessary data. User-oriented subsidies, instead of the actual company-based ones, can favour the emergence of new business models and the participation of start-ups in the mobility market to cover unserved needs (POLIS, 2020).

In this regard, the pandemic seems to only have accelerated the demand for micro-mobility services. However, full exploitation of its potential faces big challenges due to many cities' scepticism on its role in the transport systems and coexistence problems in the use of public space, with many passing restrictive regulations that greatly limits its expansion.

Additionally, the shift towards individual mobility options will be highly dependent on the presence of subsidies or incentives for the purchase of cars, used often by governments to support the economic activity of the automotive sector (Lozzi, et al., 2020). Elimination of the plethora of subsidies to private car use and proper regulation of micro-mobility will be crucial to ensure that the demand shift does not lean on cars instead of sustainable mobility options.

5.2.3 Supply chain (Urban freight)

The pandemic caused a drop in global trade and disruptions on the supply chain, with limited staff, halt on production, stockouts, and stricter safety rules.\textsuperscript{28} However, even initially decreasing the total demand for deliveries during lockdown periods,\textsuperscript{29} it has simultaneously increased the demand for e-commerce, with major implications for the spatial structure of the retail sector and its vitality as on the flow of goods and its associated mobility patterns (see further detail on this in section 5.1.2).

The logistics sector has been trying to adapt rapidly to this major consumer behavioural shift but it faced a lack of workforce, assets, and resources (Lozzi, et al., 2020), spurring further the ongoing digitalization process and potential geographic reconfiguration of supply chains. A growing interest in freight-related real estate around major cities was already running before the pandemic, with freight sprawl of urban warehouses competing for land with other activities at cities’ fringe. E-commerce has also spurred interest in smaller urban warehouses, an emerging pre-pandemic trend that better fits the sustainability goals of cities (Dablanc, et al., 2018). Even urban consolidation centres have been deemed as unprofitable in the past, current e-commerce expansion and the different initiatives to reclaim public space in cities might make these transhipment points a more attractive option, as they ease the use of ‘softer’ transport modes

\textsuperscript{27} Some example of this policies are: Copenhagen, Malta, Madrid, UK. An overview of these issues can be found here.

\textsuperscript{28} In this report there is a focus on the urban mobility side of the supply chain, but a much global assessment of the impact of COVID-19 on logistics can be found here.

\textsuperscript{29} Data on this can be found in the Barometer of Urban Logistics, conducted by the Université Gustave Eiffel – Chaire Logistics City. An example here.
to do the last-mile delivery. In any case, local authorities should integrate these and other private-initiative options in integrated mobility and urban planning approach for the movement of goods in cities to a larger extent than done so far (UGE, 2020).  

E-commerce represents a much larger share of the total number of deliveries than its retail value. The fragmentation of loads and increased number of instant delivery queries imposed by e-commerce imply low delivery density, with implications for operational costs and the environmental impact of this activity especially for last-mile services (Dablanc, 2019). Public authorities need to realize their role in regulating and planning city logistics, as a crucial activity for economic vitality, due to the fact it consumes public space for the loading/unloading operations and affects through-traffic, public transit, and other transport modes or activities. This is especially challenging in densely populated areas that cluster economic activity.

Delivery operations imply specific requirements and intense use of kerbside parking spaces. Local authorities must engage in collaboration with LSPs to assess the demand for delivery activities introducing strategies for a more dynamic and flexible parking space allocation ( (Roca-Riu, Cao, Dakic, & Menendez, 2017); (Roca-Riu, 2020)). With a prospect of more frequent and shorter stops, public authorities should promote the partnership between LSPs and spur the sharing of infrastructure, vehicles, and information systems that allow to rationalize the use of public space and minimize their operating (and social) costs. In the same line, it is necessary to promote the use of soft modes (like cargo-bikes and scooters) for freight movements in the last-mile. The pandemic has also brought to the forefront the necessity to think on how to intervene on the cities’ time-schedules, encouraging staked working hours and delivery time windows to help reduce the concentration of travellers and goods flows during certain hours.

5.2.4 Parking

Surprisingly it is often disregarded that parking shapes our cities. Cars are stationary 95% of their life-span, imposing the need to allocate an enormous amount of land to store them, being the major link between transport and urban planning. This affects both the economic and physical layout of our cities, influencing housing and retail prices due to its intermediate good nature.

As every car trip starts and finishes with a parked car, the parking sector has been equally hit by the pandemic with a huge reduction in parking demand due to lockdowns and social distancing measures, with an around 80-90% decline during the first wave peak and a posterior recovery to around 70% of pre-pandemic levels equivalent to car travel. This implied the closure of parking facilities and staff layoffs in an industry that employs around 570.000 employees and generates a turnover of 29.315M€ just in Europe (Bannerman, 2020). The most severely affected have been CBD, shopping centres, and airport facilities.  

Parking associations have advocated for governmental aid to help them cope with their financial situation, as described here and here.

---

30 E-commerce carries some intrinsic inefficiencies, like the not-at-home problem that can be addressed via click-and-collect points, delivery locker, etc.
31 When shopping malls provide free parking, they embed the parking costs in the stores’ rents that, in turn, are transferred into retail prices (Ersoy, Harker, & Inci, 2016). The effect of parking minimums on housing affordability is estimated around 12% increase for each parking spot per unit unit (Litman, 2016). When on-street paid parking is introduced housing prices per square meter are reduced around 9% (Bakis, Inci, & Senturk, 2019).
32 Parking associations have advocated for governmental aid to help them cope with their financial situation, as described here and here.
where demand plummeted the most. Another relevant trend has been the shift towards contactless payment options as a self-protection measure with a 40% increase,\textsuperscript{33} and consumers trying to avoid valet parking. This can have particularly impacted the less technologically adapted facilities in a still pretty old-fashioned sector that was rapidly transitioning before the pandemic hit. All this is likely to render many parking facilities unprofitable, as they will not be able to subsist with capacity reductions due to self-parking space requirements (previously operating on a valet parking basis) and won’t be able to afford technological adaptations.

It is important to highlight that garage parking is not as easy to repurpose as empty surface parking lots. Big operators are better equipped to weather this storm, as their operation already leans on digitalization, but this can also imply an increase in market concentration that will lead to higher parking prices.\textsuperscript{34} Any potential plummet in garage supply might heavily impact cruising by pushing more drivers toward kerbside parking, especially when evidence suggests that car usage might be increasing while public transit ridership recovery is lagging.

Further discussion of the impact of specific parking measures implemented during the pandemic can be found in the next section.

\section*{5.3 Impact of mobility-related measures implemented by cities}

In previous chapters (and this one), it has been discussed how the pandemic has already affected travel behaviours and transportation system operations. In previous sections, it has been reviewed how COVID-19 has just modulated trends that were in motion way before the pandemic started, by changing the scheme of incentives faced by consumers. It was also reviewed how these trends interplay with the mobility marketplace affecting its industry. Cities are continuously experimenting with policy measures which effectively address social distancing and reflect the ‘new normality’, while they still try to steer it towards achieving their pre-pandemic-set goals.

In this section, several factors are explored, namely, expected changes in accessibility and transport costs introduced by some of these specific policies, combined with the new set of incentives and behavioural changes introduced by the pandemic, can affect the mobility marketplace moving forward. The review is conducted by grouping different interventions based on strategies to promote public transit safety, reclaiming public space and sustainable mobility promotion, and traffic management and car access restrictions. It is offered a tentative qualitative evaluation of the economic impacts of mobility-related measures implemented by cities grouping different interventions.

\subsection*{5.3.1 Safer public transit}

To bring back riders to public transit public authorities have concentrated on implementing measures like expanding cleaning protocols, making it compulsory to wear a mask, conducting temperature checks at bus

\textsuperscript{33} Based on Mastercard data, as described \url{here}.

\textsuperscript{34} The dominance position of garage operators in a given area confers them higher market power, correlated with higher prices (Albalate & Gragera, 2017).
stops/train stations, and increase their communication efforts about hygiene recommendations. This was further seconded by transit operators adapting their services, capacity, and schedules to meet the imposed social distancing restrictions, ensuring the use of protective equipment by their staff, and implementing efforts to monitor and communicate crowding conditions in their services. This commendable effort has allowed them to keep running serving a basic need for many citizens.

As described in section 5.1.2, public transit strength is in numbers but the pandemic has transformed it into its main weakness. These months in the pandemic have made relatively clear that it is unsustainable (if not unfeasible) to keep running transit systems below a certain occupancy threshold unless enormous increases in subsidies are made (or fees). Huge efforts need to be devoted to making transit systems more efficient to put them in a position to overcome current and prospective financial situations. There is a need to relax capacity restrictions due to social distancing measures to levels that ensure that the congestion relief effect it brings to the table is greater than the subsidies it requires. With the actual shift towards individual mobility, there is a need to ensure that ridership lost by public transit transfers towards micromobility options instead of private cars. In this regard, it is likely that it will pay off to lean transit system towards more flexible and scalable modes (buses) and integrating them with micromobility options. Several cities have started to do so by classifying alternative sustainable modes as essential services, especially with bike shops and bikesharing services.

In any case, regarding public transit safe use, certainly, less focus should be placed on scrubbing surfaces and much more on improving ventilation conditions. This is especially relevant as it is clearer that COVID-19 spread relies heavily on airborne transmission and it gets even more significant with the need to increase occupancy levels. Complementary measures to make public transit more efficient while reducing peak occupancy levels need to be implemented. Several cities have made efforts to extend their bus priority lanes networks, increasing the accessibility of public transit improving its competitiveness compared with car usage. Many did also promote the relaxation of working hours, with broad adoption of work-from-home, and staggered work shifts. These strategies aiming at flattening transit ridership demand during rush hours to eliminate crowding have a potential side effect, by unintendedly making car usage more appealing if commuters can easily avoid traffic congestion periods.

As described above and in section 5.1.2 the trade-off between commuting and housing costs is likely to allow for residential relocation to the suburbs. This is likely to increase the average travel distance for commutes, increasing the appeal of car travel. It is believed that special attention should be placed on public transit provision in high-amenity areas in the city suburbs (neighbouring municipalities within each city’s metropolitan area). This is to reduce car dependence of new relocations due to lack of convenient transit options.

Lastly, it is important to highlight that all these commendable efforts will still collide with users’ perception that makes them avoid the use of public transit out of fear of potential infection. The previous measures are extremely necessary, yet they might need to be accompanied by larger communication efforts and avoiding to institutionalize the fear of public transit use. It is acknowledged this can be a politically thin line to navigate while outbreaks still appear until a large percentage of people are vaccinated (or better treatments keep hospitalizations at bay). However, the lack of a proper causal study on the risk of infection imposed by public transit requires for extreme caution on how restriction measures are communicated to avoid promoting counterproductive dread behaviour.
5.3.2 Reclaiming public space and sustainable mobility promotion

The other main strategy followed by most cities has been to take advantage of the pandemic to further expand their interventions aiming at reclaiming public space from cars to devote it to other transportation modes, which during the pandemic has been framed especially towards ensuring proper social distancing. For many cities, these measures were already pre-established in their SUMPs and are now just brought to the front of their priorities. These measures mainly consisted of the extension of sidewalks, pedestrianization of entire streets sections, and pop-up bike lanes, mostly by transforming traffic lanes and kerbside parking to ensure proper social distancing.35

Allocating a larger share of public space to sustainable transport modes can be helpful to tackle the shift towards individual mobility introduced by the pandemic, making micromobility options more attractive. Bike lanes (and their quality) have been shown to promote cycling by improving its attractiveness due to increased travel speed, network connectivity, and perception of safety (Rietveld & Daniel, 2004); (Marqués, Hernández-Herrador, Calvo-Salazar, & García-Cebrián, 2015); (Xu & Chow, 2020)). With very modest investments, if well implemented, bike lanes can offer great improvements to cyclists and potentially contributing to address multiple issues like congestion, greenhouse gas emissions, air pollution, and provide additional health benefits (COWI, 2008); (Gu, Mohit, & Muennig, 2017). In any case, car demand cross-elasticities to cycling infrastructures improvements are too low to bring significant traffic reductions on its own. However, estimated valuations of improved cycling travel times, comfort and safety are high enough to justify most of these measures, even there are still issues unsolved when dealing with how to conduct cycling infrastructure project appraisals (Börjesson, Bastian, & Eliasson, 2020); (Ruffino & Jarre, 2020).

If implemented at a large scale, these measures imply a reduction in road capacity for cars, which also translates into higher transport costs due to increased congestion if its demand stays relatively unchanged (or even potentially increased due to the pandemic). Drivers will adapt their behaviour to the new situation and (in equilibrium) traffic will spread out across the street/road network. This means car drivers will reschedule their trip or even shift to another transport mode, which in the end means that local changes might not increase substantially the travel cost for each driver. However, the net effect of these changes on social welfare under the new space allocation will crucially depend on (a) the demand elasticity to travel cost (how many trips are forgone); (b) cross-elasticities (how many trips shift toward alternatives); (c) the supply and social cost curves characteristics (how much congestion and other external effects builds up with traffic flow in the network); and (d) the gains for the users this reclaimed space is allocated to (the opportunity cost for the alternative use of public space). Many practitioners have eagerly accepted the ‘traffic evaporation’ or equivalent ‘disappearing traffic’ concepts (Cairns, Atkins, & Goodwin, 2002) disregarding it is simply the reverse of the ‘fundamental law of congestion’ (Duranton & Turner, 2011); (Garcia-López, Pasidis, & Viladecans-Marsal, 2020)). On the one hand, ‘traffic evaporation’ depicts the loss in dissipated demand due to road supply reduction. On the other, the ‘fundamental law of congestion’ depicts the gain in induced demand due to road supply expansions. This, and other available evidence on such elasticities for car travel suggests it is quite unlikely that supply restrictions alone will be the socially optimal strategy. Solely trying to regulate demand through capacity restrictions will reduce consumer

35 An example of the need for such measures can be found here for the case of Milan sidewalks.
36 Mainly due to difficulties in demand forecasting and impacts monetization.
surplus and generate larger externalities due to drivers not being forced to internalize the external costs they impose onto others.\textsuperscript{37} This is especially relevant in the scenario that car appeal increases due to the pandemic, as discussed in section 5.2. It is strongly encouraged practitioners to combine their efforts to reclaim public space management strategies to mitigate travel demand (like road and/or parking pricing). This will allow practitioners to confront drivers with the external cost they impose and to fully exploit its benefits without causing an unintended spike in externalities.\textsuperscript{38}

For many cities, reclaiming public space and the promotion of sustainable mobility modes has gone hand in hand during the pandemic. Some cities have established free or discounted access to micromobility services, or introduced multi-modal ticketing, further promoting the shift towards individual mobility more as a collaborator to public transit than a competitor. Micromobility is largely considered by cities as an access mode to public transit, even they can be substitutive for certain trips.\textsuperscript{39} The combination of these travel options within a single trip chain can enlarge public transit spatial reach and increase its door-to-door accessibility, expanding its catchment area, and provide a competitive enough alternative to car travel (Oeschger, Carroll, & Caulfield, 2020). This is especially relevant in the post-pandemic scenario, as expected residential relocation to suburban areas could increase car appeal in areas not close enough to transit stations without this complementary travel option. It is strongly assumed the needed integration between public transit and micromobility options offers a unique opportunity to accelerate the rollout of MaaS, to enhance the flexibility and efficiency of the transport system.

Additionally, several cities have supported the previous strategies with changes in regulations aiming at promoting active transport modes (cycling and walking). An example of this is the reduction of speed limits for motor vehicles in certain areas, reducing the competitive advantage of cars to micromobility alternatives and increasing their safety. Other land-use policies were already used by cities (among other things) to help shape how people move by means of urban design interventions (being Paris – 15min City – and Barcelona – Superblocks – the most renowned examples). These policies go beyond tactical urbanism and include zoning regulations and building codes to promote the certain distribution of stores, jobs, public goods, and amenities within walking distance to most residents. These comprehensive strategies include the adoption of transit-oriented development and ensuring enough density, where reclaiming public space is probably the most readily deployable and visible intervention.

Such initiatives are implemented with a long-term vision, but the pandemic boosted their adoption. This is due to the convenience that its basic elements are able to deal with the current situation while still aiming to fullfil strategic sustainable development goals of cities. However, practitioners tend to disregard that these types of “15min-neighbourhoods” already exist, being the high-amenity most attractive locations with comparatively higher housing prices. The potentially gentrifying effect of such interventions seems to be usually disregarded, where an increase in housing prices is likely to displace less-wealthy individuals to

\textsuperscript{37} See (Litman, 2013) for a review of travel demand elasticities.

\textsuperscript{38} It is acknowledged that the actual approach to reclaiming public space first might be politically less challenging, due to better public acceptance. Moreover, doing so can even help politicians to gain support for latter implementation of price-based measures by increased its perceived benefits. However, it is important to highlight that this is done at the expense of potentially generating larger external costs, as the order of intervention matters.

\textsuperscript{39} In previous sections it was already highlighted the potential substitution effect between public transit and micromobility alternatives, but it is also true that cities with bike share programs have experienced cycling level increases beyond bike share users alone (Shaheen, Cohen, & Martin, 2013).
lower-amenity areas. The problem will likely be exacerbated when zoning and density restrictions in cities do not allow for new housing to be developed (or not being attractive to developers). The residence relocation trends will be boosted by this, and so the corresponding mobility patterns and housing size mismatch between supply and demand. Cities will get younger, as young people are the ones still building up human capital and dependent on exploiting agglomeration economies to build their professional networks. In this regard, closely monitoring the residential relocation patterns can help practitioners explore options to allow the relaxation of density restrictions or promote reconfigurations within available buildings (allowing the city to grow internally). This can reduce the mentioned mismatch and be beneficial from a housing affordability perspective, helping to reduce the suburbanization trend.

It is also important to highlight, that these initiatives can introduce incentives for retail relocation depending on how the different shops’ demand relies on visitors or resident-oriented and how much complimentary are to one another (depending on the complementary of the goods at sell). The positive demand spillovers with spatial concentration will still offer certain types of businesses incentives to cluster in specific areas. Promoting high-amenity areas with large spaces for pedestrians will likely increase footfall in certain areas (and reduce it in others), affecting the potential revenues for different businesses depending on their location. Practitioners need to be aware that during the reconfiguration transition they will likely face strong opposition by those losing with the change. Additionally, this pressure can be even higher due to the retail sector situation in the aftermath of the pandemic, yet offering a clean slate to boost changes in the areas of intervention.

Additionally, a similar argument can be applied to job location patterns. The ‘15min City’ principles seem to implicitly assume a relatively homogeneous dispersion of employment at odds with the available evidence. It is pretty hard to assume that all residents would be able to reside close to their job site, given the uncoordinated equilibrium between the decisions of the different agents. Companies still get the benefit from economies of agglomeration, even attenuated by the digitalization of the economy and working-from-home broad adoption. So they will tend to cluster, and so will do employees choosing where to live. The wealthy will tend to live close if the amenity effect is still prevalent after the pandemic, but less-favoured groups will rarely be able to afford to live close to their employment site. This needs to be specifically taken into account in the pandemic’s aftermath, as less-favoured groups are heavily relying on public transit. It is crucial that the transport system is adapted to this reality and allows less-favoured groups to easily reach distant economic opportunities. In this regard, there are examples of the negative effects of constrained employment opportunities due to travel limitations, with women being paid 4% less per hour and having a 12% shorter commute than men. This suggests that women are trading off commute time for wage to a larger extent than their male counterparts due to time-budget constraints associated to childcare duties (Le Barbanchon, Rathelot, & Roulet, 2020).

Finally, cities have also undertaken increased communication about climate-friendly mobility options. However, there exists mixed evidence on whether these are effective tools to promote sustainable travel options on their own. Some reviews suggest that neither incentives nor mass media or publicity campaigns result in significant increases in the adoption of these travel options; while few targeted behaviour change programs seem to yield minor modifications (Winters, Buehler, & Götschi, 2017).

For further context it is referred the reader to the review of these issues offered in section 0.
5.3.3 Traffic management and car access restrictions

The pandemic has also made some cities to focus on tweaking the policy tools already implemented to affect the mobility system, modulating transport demand, and segmenting it outside peak hours. In this subsection, it is reviewed the impacts associated with Low emission zones (LEZs) and changes in parking regulations.

LEZs have been implemented by cities aiming to improve air quality in cities. This is done to achieve compliance with the EU limit values and bring health benefits for its population. This quantity-based regulation tries to limit the amount of pollution by motor vehicles in an area, by restricting the access to those with emission levels above a certain threshold.

A review of available evidence on the impact of LEZs on air quality shows mixed results. The determination of such impact is difficult due to the potential influence of many confounding factors, like changing meteorological conditions, vehicle fleet characteristics, traffic flows, or the composition of traffic close to the measurement stations that are also affected by other policies. When these issues are accounted for, available evidence suggests that LEZs alone are hardly making a major impact on air quality improvements (Boogaard, et al., 2012; Holman, Harrison, & Querol, 2015). Modelling studies undertaken in pre-implementation phases tend to be overoptimistic showing much larger impacts than the ones observed based on pollution measurement stations’ data. Robust available estimates being below 5%-10% reductions in PM$_{10}$ and to a lesser extent in NO$_x$ (even non-significant effects are also reported).

LEZs can also be used as a tool to trigger vehicle fleet renewal. Results for different cities suggest that its introduction increased the rate of fleet turnover in the early phases, with a shift towards cleaner vehicles dependent on the stringency of the emissions threshold and whether they affect heavy vehicles (Ellison, Greaves, & Hensher, 2013; Ferreira, et al., 2015). In the current pandemic scenario this can be a convenient tool to further incentivize that the shift towards individual mobility, if implying an increase in car ownership, it at least goes in the positive direction of improving vehicle fleet energy efficiency. Unfortunately, to the best of our knowledge, there is no available evidence yet on how the combination of the pandemic and LEZs are helping cities make a greener recovery or push the fleet turnover towards greener options. The effectiveness of LEZ will depend on the initial share of polluting cars, fading out as the fleet gets renovated. In this regard, there is a need to highlight that equity considerations are also raised. A potential high car renovation particularly can be daunting for less-affluent social groups, where a pricing system differentiated by emission levels is deemed to be better than a ban (Börjesson, Bastian, & Eliasson, 2020).

Although this was not the aim of LEZ, some city officials have marketed them as a tool to reduce congestion. However, evidence suggests that the share of polluting vehicles (linked to the stringency of its emission levels threshold) is not high enough to allow LEZs to simultaneously address both pollution and congestion. Tolls are superior at tackling congestion and more efficient than LEZs (Bernardo, Fageda, & Flores-Fillol, 2014).

---

41 Other studies showing big impacts are available, most with naive before-after comparisons, however they are discarded as reliable evidence due to not applying proper statistical techniques allowing them to controlling for the previously described potential confounders.
However, they enjoy far lower public acceptance than either LEZs or parking regulations. The trends spurred by the pandemic make road pricing or congestion charging even more relevant than before.

These pricing policies can allow cities to modulate the incentives for suburban residential relocation by rising travel costs for cars, allowing for larger modal shifts towards public transit (once back to ‘normal’). These can prevent a new round of urban sprawl, counterbalancing the push (outward) force introduced by the pandemic (at least to some extent). Both road pricing policies and 15min-neighbourhoods are expected to drive prices up in the city once urban amenities can be taken advantage to their full extent. However, this can potentially put more pressure on the housing market and grow the need for a reconfiguration or expansion of housing supply, needing careful reconsideration of imposed zoning and density limits.

Additionally, the public sector has implemented measures that affected the parking market via kerbside parking. Many cities reduced kerbside spaces to make room for pop-up bike lanes, extending loading/unloading areas to reduce the pressure of increased deliveries, and increasing the space devoted to restaurant/bar terraces (to ensure proper social distancing). During the first wave, parking meters and enforcement were suspended in many places, with kerbside and residential parking fees waived. Reason behind this was to facilitate the safe travel of essential workers and ease the parking conditions for residents in many neighbourhoods. This strategy has been kept in some places during the latter phases of the pandemic as a way to alleviate the economic impact of the pandemic on the retail sector (even granting them pick-up/take-away parking spaces).

Unfortunately, these interventions seem to disregard the available evidence on the intrinsic inefficiencies present in the parking market and how its different stakeholders interact. Kerbside parking prices are generally kept too low, with each car occupying a spot imposing significant search externality to others forcing them to cruise for an empty spot. This phenomenon affects a relevant number of trips and produces sizeable welfare losses. This distortion goes even further when it is accounted for the fact that kerbside and garage parking are not perfect substitutes, meaning that drivers are willing to pay a premium to park on-street (Gragera & Albalate, 2016). Thus, there is more demand pressure to park on-street that causes cruising levels to raise. Garages can exploit this to charge higher prices due to localized market power (due to the combination of construction scale economies and walking costs), further worsening the inefficient pricing scheme due to lack of an integrated parking management approach. It is known that parking availability and cost are major determinants of car ownership and usage, with residential parking permits issued in most cities implying a subsidy to car ownership that increases motorization levels with negative welfare implications (Albalate & Gragera, 2020).

Examples of such measures can be found for several cities here. Available studies providing estimates of these external costs suggest that they are quite heterogeneous depending on the parking regulatory setting. (Van Ommeren, Wentink, & Dekkers, 2011) report it to be around 1€ per day in Amsterdam (with efficient regulation); while (Inci, van Ommeren, & Kobus, 2017) suggest that it is about 15% of the average wage rate in Istanbul, similar in magnitude as the congestion costs in this city. In order to efficiently allocate parking demand between kerbside and garage parking it is necessary that the price differential between them is optimally set, taking into account how the private sector would respond (Albalate & Gragera, 2017) and potential strategic behavior with information provision (Albalate & Gragera, 2018).
If there is focus on how things will look like moving forward, it can be thought that broad adoption levels of telecommuting might reduce the demand for parking in central locations and increase it in the suburbs, as explained in section 5.1.2. However, how this plays out will crucially depend on how this translates into a modal shift, as more car trips can also be expected.\textsuperscript{45} In any case, changes in demand and supply will be heterogeneous across the city and a higher degree of flexibility in how to access available parking supply is likely to be needed. This is especially relevant to foster a city-wide public space reclaiming strategy that will force cars to be preferentially parked off-street.\textsuperscript{46} Parking facilities might also be able to take advantage of such changes by undertaking a transformation into mobility hubs, allowing relieving kerbside space by moving several transport modes and activities to off-street. This is especially relevant when considering the expansion of e-commerce and the increased need for urban warehouses, as described in the previous subsection.

Moreover, the pandemic offers the public sector a great opportunity to tackle parking inefficiencies. Parking regulation is a suitable management tool to mitigate travel demand. Therefore, it is already implemented (to a different extent) in most European cities, facing less political backlash than congestion charging or other forms of road pricing. Being in control of curbside parking supply and pricing allows public authorities to revert current price differentials between garages and the curb. Additionally, it does also offer authorities the opportunity to confront residents with the true cost of car ownership via market-price residential permits (or at least high enough to avoid promoting motorization rate increases).

Surprisingly enough several cities suspended most of these travel demand management measures, relaxing codes and rules around car travel during the early stages of the pandemic to help essential workers get to work and make life easier for residents (voters). This can easily further reinforce the idea that public transit should be avoided and fuelled the shift towards individual mobility. Most have re-enacted them and some plan to expand their scope motivated by the pandemic (and prospect fiscal deficits). An example of this is London’s plan to raise congestion charge by 30% as part of the public transit bailout plan, and Barcelona’s decision to extend its parking regulating area to the outskirts of the city.\textsuperscript{47}

The discussion raised in this chapter aims to help practitioners realize the interactions between the different policies and interlinked housing, job, and transport markets.

\textbf{5.4 Discussion}

The pandemic and social distancing measures have fundamentally affected the forces shaping cities. It has exponentially increased the agglomeration negative effects (risk of infection) and made it difficult to exploit positive agglomeration effects (production and urban amenities). This affects the trade-offs faced by households and firms in their decisions and changes the incentives for their spatial location or mode choice. Thus, affecting the housing market, the layout of economic activity and mobility flows.

\textsuperscript{45} Timid evidence of this is the increased interest in parking spaces as a real estate investment during the early stages of the pandemic, as described here.\textsuperscript{46} Companies allowing to easily transform previously idle private-access parking spaces into public-access ones, with more or less evolved shared parking schemes (like WeSmartPark or JustPark)\textsuperscript{47} Further detail on these measures can be consulted here and here.
Telecommuting broad adoption also disrupted these forces. Its expected net impact on mobility patterns depends on the combination of the increase in distance travelled (relocation effect) and the frequency of commute trips (substitution effect). Early evidence suggests it can promote urban sprawl and increase car usage appeal for households, while for firms the relocation drive will depend on how much they rely on agglomeration economies, the cost-efficiency of reduced space needs (rents), and their ability to exploit the lower wage compensations for workers commuting.

Shopping behavioural changes have also a translation into a decline in brick-and-mortar retail potentially leading to urban blight and a reduction of the attractiveness of certain areas (loss of the amenity effect). Moreover, it also has implications on the flow of goods, the fragmentation of loads, an increased number of instant delivery queries that imply higher operational costs, and the environmental impacts of logistic activities.

The major blow has been taken by public transit, with the effects of the economic crisis likely putting even heavier pressure on transit subsidies. Capacity restrictions (institutionalized ‘fear to public transit’) imposing operation at low occupancies eliminate public transit competitive advantage, diminishing its congestion relief effect and further increase the pressure on subsidies. Making transit systems more efficient and lifting such constraints (as much as possible) should be the priority to overcome current and prospective financial situations. Communication campaigns targeting users’ risk perception need to be implemented. There is an urgent need to ensure that ridership lost transfers towards micromobility options instead of private cars, as they are considered as access modes to public transit (even they can be substitutive for certain trips). It will pay off to lean the transit system towards more flexible and scalable modes, further integrating it with micromobility options accelerating the rollout of MaaS. Regulatory approaches that are less belligerent against private-initiative shared services will help their economic viability, increasing the mobility system flexibility. Adapting transit services to account for potential households’ suburbanization and firms’ agglomeration trends triggered by telecommuting broad adoption will also be advisable (avoid car-dependence).

With the modal shift towards individual mobility, walking and cycling are the clear winners so far with an increase in car appeal too. Whether car ownership rises will boil down to the larger appeal of cars overcoming financial constraints and disincentives implemented by cities and national governments. Allocating a larger share of public space to sustainable transport modes can be helpful to tackle the shift towards individual mobility introduced by the pandemic (bike lanes and other uses), yet these measures need to be accompanied by complementary travel demand management tools (price-based) to overcome its potential negative effects.

Cities responded to the pandemic by implementing measures to promote public transit safety, reclaiming public space and sustainable mobility promotion, and traffic management and car access restrictions. These interventions aim to abate the negative effects of the pandemic while pursuing strategic city goals. However, policymakers tended to disregard the mid/long-term behavioural shifts introduced by the pandemic (described above). They are reviewed through the lens of the interplay between transportation, housing, and job markets to provide some guidance on how to take advantage of the opportunities this crisis brought to address distortions in the mobility market (while helping with the climate and housing crisis).
Conclusion

Urban systems, and particularly, urban mobility systems, as it can be concluded, are in constant adaptation. The pandemic and social distancing measures have fundamentally affected the forces shaping cities. It has exponentially increased the agglomeration negative effects (risk of infection) and made it difficult to exploit positive agglomeration effects (production and urban amenities). Therefore, the pandemic has created many problems to be solved, amongst other increasing concerns of citizens about their safety. However, although the pandemic might face an end in the near future, pre-pandemic urban mobility challenges such as climate change, urban health, social inclusion and cohesion, competitive economy, new models of governances and innovation technology will prevail. Cities are trying to face these challenges with various strategic approaches – most of them can be summed up in three main categories: proximity urban planning, seamless inter-modality and public space redesign (see section 1.2).

From the taxonomy generated in this report about the challenges and strategies that cities were already applying before COVID-19, two hypotheses could be outlined: cities are not reconsidering their long-term mobility strategies (first hypothesis), but on the contrary, using the COVID-19 measures to foster some of them (second hypothesis) – see section 1.4. These hypotheses mark a direction urban mobility could take. However, it is important to note differences between cities and countries. As it was clear from the survey conducted for this study, not all cities have implemented the same measures with the same intentions (short term vs. long term). Within the EU there is a very diverse set of local and national subsidies and governmental support, thereby, different cities in different countries will benefit from dissimilar scenarios.

Distinct scenarios can be found in different cities. Such as the ones who barely changed their plans or infrastructures compared to the already existing ones; others due to staff redeployment and budget constraints had to put most of their strategic plans on hold to tackle more urgent health needs created by the pandemic; and others that had the chance to push new mobility projects they had in the pipeline forward as the need for change became even more evident with the pandemic.

Therefore, confirming what was described, some cities have used COVID-19 in their favour to foster the development of mobility plans and/or new measures to transform their mobility system taking advantage of the clear window of opportunity. Cities did not radically change with the pandemic, instead, they adapted and evolved at a higher pace with already existent solutions but not yet deployed at a higher scale. Accordingly, COVID-19 did not prove to be a decisive factor in the urban mobility systems as it can be understood from the survey results in the 2, 3, and 4 Chapters. COVID-19 proved to be an accelerator for urban development.

Lastly, the economic blow created by this scenario must be carefully understood. The interplay between citizen and logistics transportation, housing, and job markets has to be considered. Urban infrastructure and regulations should take into account the eventually lasting effects of the pandemic on the modal share of urban transports (e.g. decrease of use of public transport and alternative modes). Likewise, active modes of mobility such as biking, must be linked to the new housing requirements due to the possibility of teleworking. In addition, the shift from local shopping to e-commerce can create changes in the urban commerce, also supported by new housing possibilities and logistics. The mobility system is far much more
than moving objects or people from point A to B, it also dictates the economic development of an urban environment as it can be read in the 5 Chapter.

**Key Recommendations:**

Based on the analysis done for this study key recommendations for different stakeholders in urban mobility systems can be derived.

For local governments:

- According to your resources, try to move up the “maturity scale” on organising for innovation and data-driven decision making. Identify a broader set of relevant stakeholders and collaborate with them to implement new mobility strategies and solutions.
- Learn from global experiences and best practice but adapt them to your local context.
- To learn from the public behaviour during the pandemic it will pay off to lean the transit system towards more flexible and scalable modes, further integrating it with micromobility options. Regulatory approaches that are open for private-initiative shared services will incorporate economic viability and will increase the needed mobility system flexibility.
- Consider short-term reactions on COVID-19, such as the reclaim of road space for pedestrians, as long-term opportunities for reshaping urban mobility systems.
- Allocating a larger share of public space to sustainable transport modes can be helpful to tackle the shift towards individual mobility introduced by the pandemic (bike lanes and other uses). These measures should be accompanied by price-based complementary travel demand management tools to overcome its potential negative effects.

For policymakers and funding programs on national and EU level:

- Provide support for cities to organise for innovation and collaboration – both internally and with external stakeholders. Additionally, support the collection and utilization of data aiming at the transformation of cities’ mobility systems.
- Provide support in terms of models, tools and mechanisms for scaling and spreading best practice in urban mobility to all cities - despite their size and maturity level.
- Provide support for the acceleration of projects supporting active modes of transport utilizing current changes in user behaviour.
- It is advisable to adapt transit services (to avoid car-dependence) to households’ suburbanization trends and to the agglomeration drift of companies which are triggered by telecommuting broad adoption.
For mobility service providers:

- Align your services with the political goals for future mobility system.
- Open up for a structured collaboration with local government and learn how you can contribute to the mobility system’s improvement, finding a working business model within that frame.
- React on current trend, but always consider long-term effects and political targets (e.g. intermodality, sustainability or data-driven solutions) when collaborating with governmental institutions.
- Communication campaigns targeting users’ risk perception during and after the pandemic need to be implemented. There is an urgent need to ensure that lost ridership of public transport is directed towards micromobility options instead of private cars. Micromobility options are of high importance as they are considered as access modes to public transit.
Bibliography


CIVITAS. (2020). *We dare to...* Retrieved from https://epub.civitas.eu/.we-dare-to/


NESTA. (2020). *From the Margins to the Mainstream, How to create the conditions for new operating models to thrive*. NESTA.


C40 Mayors Recovery Task Force. (2020). Technical report: The case for a green and just recovery. Retrieved from https://c40.my.salesforce.com/sfc/p/#360000001Enhz/a/1Q0000000gRCH/24Og5bRwj1hZ305yJbyPMZJQKhXXWNYE8k8sr2ADsi8


Observatory of Public Sector Innovation. (2017). Fostering Innovation in the Public Sector, p70 fig 2.25. OECD.


Cities Climate Finance Leadership Alliance. (2020). The Cities Climate Finance Leadership Alliance is a coalition of leaders committed to deploying finance for city level climate action at scale by 2030. Retrieved from Cities Climate Finance Leadership Alliance: https://www.citiesclimatefinance.org/


Andersson, L., Gläfke, A., Möller, T., & Schneiderbauer, T. (2020, 07 15). Why shared mobility is poised to make a comeback after the crisis.


Castilla, J., Godoy, P., Domínguez, Á., Martín, V., Delgado - Rodríguez, M., Martínez - Baz, I., & Quintana, J. M. (2013). Risk factors and effectiveness of preventive measures against influenza in the community. *Influenza and other respiratory viruses, 7*(2), 177-183.


Cardiff City Council. (2020, Jun 5). *Cardiff’s plans to exit lockdown as one of UK’s ‘safest’ cities revealed.* Retrieved from Cardiff News Room: https://www.cardifffnewssroom.co.uk/releases/c25/24027.html


C40 Cities Climate Leadership Group. (2019, March). *How to design and implement a clean air or low emission zone.* Retrieved from C40 Knowledge Hub:
How to design and implement a clean air or low-emission zone? language=en_US


CIVITAS. (2020). We dare to... Retrieved from https://epub.civitas.eu/we-dare-to/


NESTA. (2020). *From the Margins to the Mainstream, How to create the conditions for new operating models to thrive*. NESTA.


C40 Mayors Recovery Task Force. (2020). *Technicial report: The case for a green and just recovery*. Retrieved from https://c40.my.salesforce.com/sfc/p/#/360000001Enhz/a/1Q0000000gRCH/240gSbRwj1hZ305yJbyPMZJQKhXXWNYE8k8sr2ADsi8


Observatory of Public Sector Innovation. (2017). *Fostering Innovation in the Public Sector, p70 fig 2.25*. OECD.


Cities Climate Finance Leadership Alliance. (2020). The Cities Climate Finance Leadership Alliance is a coalition of leaders committed to deploying finance for city level climate action at scale by 2030. Retrieved from Cities Climate Finance Leadership Alliance: https://www.citiesclimatefinance.org/


Andersson, L., Gläfke, A., Möller, T., & Schneiderbauer, T. (2020, 07 15). Why shared mobility is poised to make a comeback after the crisis.


Castilla, J., Godoy, P., Domínguez, Á., Martín, V., Delgado - Rodríguez, M., Martínez - Baz, I., & Quintana, J. M. (2013). Risk factors and effectiveness of preventive measures against influenza in the community. *Influenza and other respiratory viruses, 7*(2), 177-183.


Roca-Riu, M., Cao, J., Dakic, I., & Menendez, M. (2017). Designing dynamic delivery parking spots in urban areas to reduce traffic disruptions. *Journal of Advanced Transportation, 2017*. 162


