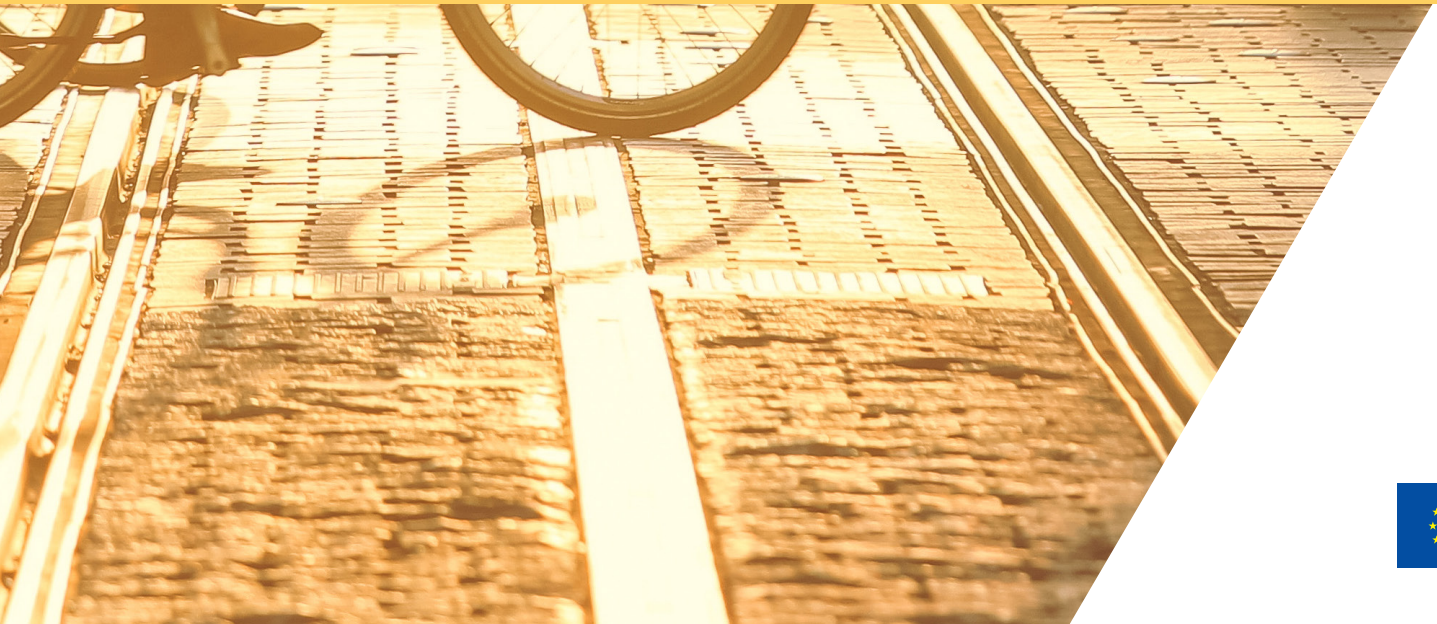
European Platform on Sustainable Urban Mobility Plans

TOPIC GUIDE:

PLANNING FOR MORE RESILIENT AND ROBUST URBAN MOBILITY



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CIVITAS Handshake is helping cities become more liveable by improving conditions for cycling as an everyday mode of transport. The project focuses on all stages of delivery, from planning to implementation and monitoring of success, aided by governance arrangements to transition towards a greater quality of life through increased cycling.*

CityChangerCargoBike builds on the limitless potential of cargo bikes, promoting their usage among public, private, and commercial users. The project focuses specifically on the positive role of cycle logistics, deliveries and supply chains.*

HARMONY project works to provide decision makers with a new generation of tools, policy recommendations and guidelines to lead the transition to the new mobility era. Their solutions aim to bridge the transport gap between metropolitan regions and neighbouring areas, working towards a resilient, sustainable, and intermodal transport system.*

The **GECKO** project aims to support authorities in developing the most appropriate regulatory framework and governance model, through guidance, recommendations and case studies, for the transition to a new mobility era of cooperative, inclusive, competitive, sustainable and interconnected mobility across all modes, through evidence-based research.

MOMENTUM aims to develop a set of new data analysis methods, transport models and planning support tools to capture the impact of new transport services (MaaS, Connected Automated Vehicles, shared mobility services and demand responsive transport) 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 these emerging mobility solutions.*

GreenCharge aims at developing zero emission mobility combined with innovative business models, technologies and guidelines for cost efficient deployment and operation of charging infrastructure for EVs.*

The **ELVITEN** project main objective was to enhance users' awareness about about light electrified vehicles. The partners have collected and analysed various types of data related to the trips, the charging behaviour and the use of ELVITEN support and motivation ICT tools. The project has generated guidelines for vehicles manufacturers, service providers and planning authorities for the better integration of such vehicles in the transportation and electricity networks.

eCharge4Drivers is an H2020 project that works to substantially improve the EV charging experience within cities and for long trips. The project will develop and demonstrate user-friendly charging stations and innovative charging solutions as well as smart charging services for the users.

Park4SUMP aims to help cities integrate smart parking management solutions into sustainable urban mobility plans. The key objectives of the project are: helping cities to integrate parking management into their (future) SUMP, freeing up an average of 10% of public space currently used for parking and investing at least 10% of parking revenues into sustainable transport, active modes or developments for more human-centred neighbourhoods.*

The goal of **ReVeAL** is to support cities producing good practice in UVAR (Urban Vehicle Access Regulations) and to add UVARs to the standard range of urban mobility approaches across Europe and beyond. The ReVeAL project supports UVAR implementation in six pilot cities and is developing a tool to help other cities decide which UVAR measures may be appropriate for them and what to be aware of when implementing.*

SPROUT provides a new city-led innovative and data-driven policy response to address the impacts of emerging mobility patterns, digitally-enabled operating & business models, and transport users' needs. Starting from an understanding of the transition in urban mobility, the project will define the impacts on the sustainability and policy level. It will also harness these through a city-led innovative policy response. The aim is to build cities' data-driven capacity to identify, track and deploy innovative urban mobility solutions.*

CIVITAS ELEVATE's mission is to increase the Europe-wide impact of the CIVITAS (R)IA projects on urban mobility policymaking, thereby advancing the CIVITAS community to a higher level of knowledge, exchange, impact and sustainability, while guaranteeing essential high-quality support. It is the follow-on Coordination and Support Action from CIVITAS SATELLITE.

TInnGO is a research project funded in the context of the HORIZON 2020 Programme of the EU, aiming to create a framework and mechanisms for a sustainable game change in European transport through a transformative strategy of gender and diversity sensitive smart mobility.

EUROCLIMA+ is a regional cooperation programme that fosters climate-resilient and sustainable development in 18 countries in Latin America. In this framework, this project is aimed to provide support for the development of sustainable urban mobility in Latin America through direct support to Latin American partners and GIZ in the development of the EUROCLIMA+ Sustainable Urban Mobility Plans (SUMPs) in three pilot cities.

SUNRISE addresses mobility challenges at the neighbourhood level in six cities. It entails activities along the entire innovation chain: Identification of mobility problems, development of innovative ideas, concrete implementation, systematic evaluation, extraction of lessons learned and their dissemination in the form of a "Neighbourhood Mobility Pathfinder." Local residents, businesses and other stakeholders will be involved in all phases to live up to SUNRISE's "co-creation" spirit.*

The **SOLUTIONSplus** Project - Integrating Urban Electric Mobility Solutions in the Context of the Paris Agreement, the Sustainable Development Goals and the New Urban Agenda - aims to set up a global platform for shared, public and commercial e-mobility solutions. The 46 project partners are working on the widespread transition towards low-carbon urban mobility.

SUITS is one of three CIVITAS SUMPs-related projects working to towards a common goal: to support cities across Europe to develop and implement Sustainable Urban Mobility Plans. By enhancing cooperation among the Member States, the CIVITAS SUMP projects make it possible to lower the barriers to the implementation of more energy-efficient and sustainable urban mobility planning in an integrated way that would not be possible within one country alone.*

Projects marked with a * fall under the umbrella of the **CIVITAS Initiative**. Through such projects, CIVITAS helps cities to test and develop integrated sets of measures for sustainable urban mobility.

Contents

Guide to the reader

This document provides guidance on a specific topic related to Sustainable Urban Mobility Planning (SUMP). It is based on the concept of SUMP as outlined by the European Commission's Urban Mobility Package 1 and described in detail in the European SUMP Guidelines (second edition)[1].

Sustainable Urban Mobility Planning is a strategic and integrated approach to dealing with the complexity of urban transport. Its core goal is to improve accessibility and quality of life by achieving a shift towards sustainable mobility. SUMP advocates for fact-based decision making guided by a long-term vision for sustainable mobility. It requires a thorough assessment of the current situation and future trends, a common vision with strategic objectives and an integrated set of regulatory, promotional, financial, technical and infrastructure measures. Implementing these measures to deliver the objectives should also be accompanied by reliable monitoring and evaluation.

In contrast to traditional planning approaches, SUMP places particular emphasis on the involvement and cooperation across different layers of government and with citizens, stakeholders and private actors. Emphasis should also be put on the coordination of policies between sectors (transport, land use, environment, economic development, social policy, health, safety, energy, etc.).

This document is part of a compendium of guides and briefings that complement the newly updated second edition of the SUMP Guidelines.
They elaborate on difficult planning aspects in more detail, provide guidance for specific contexts, or focus on important policy fields. Two types of documents exist: while 'Topic Guides'provide comprehensive planning recommendations on established topics, 'Practitioner Briefings' are less elaborate documents addressing emerging topics with a higher level of uncertainty. [2]

[1] Rupprecht Consult - Forschung & Beratung GmbH (editor), 2019. Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan, Second Edition.

[2] Guides and briefings on how to address the following topics in a SUMP process have been published since the publication of the SUMP Guidelines:

- Planning process: Participation; Monitoring and evaluation; Institutional cooperation; Measure selection; Action planning; Funding and financing; Procurement.
- Contexts: Metropolitan regions; Polycentric regions; Smaller cities; National support.
- Policy fields: Safety; Health; Energy (SECAPs); Logistics; Walking; Cycling; Parking; Shared mobility; Mobility as a Service; Intelligent Transport Systems; Electrification; Access regulation; Automation; COVID-19; Gender and vulnerable groups.

They are part of a growing knowledge base that will be regularly updated with new guides. These documents can be found in the 'Mobility Plans' section of the European Commission's urban mobility portal Eltis (www.eltis.org).

Executive summary

This document addresses planning in uncertain times when a major crisis is triggering significant changes in all areas. An immediate crisis can cause further long-term changes and increase the impact of other major trends, such as climate change. Managing such fundamental change processes is a key challenge for urban mobility practitioners to integrate into their plans. In this document, a crisis can be defined as any event that may lead to an unstable and dangerous situation which affects the urban mobility systems or whose impact, duration and severity are affected by the urban mobility system. Crises covered in this guide include, but are not limited to, natural or man-made disasters, pandemics, economic crises, social crises, environmental crisis, terrorism, cyberattacks, geopolitical crises, etc.

This document is the attempt to articulate generic lessons from how urban mobility systems responded to and were managed during the COVID-19 pandemic. Since the onset of the pandemic, public transport use has been severely reduced, while other modes were rising in popularity. It may sound like a platitude, but it is now truer than ever: Due to the inherent uncertainty of future developments, cities must remain flexible.

The climate crisis and other major change processes have been disrupting and continue to disrupt the status quo cities. The necessity to handle these uncertainties and impacts will increase in the years to come.
While COVID-19 was the initial impetus for the creation of this guide, this document is intended to suggest responses to this crisis but also to contribute to resilience planning for any future crises. More specifically, it aims at including resilience principles in sustainable urban mobility planning (SUMP).

The first section of this topic guide first introduces the concept of resilience in the context of urban mobility and the importance of integrating it into the SUMP procedure. It presents the 4 phases of the SUMP cycle with a resilience focus.

The second section addresses specific resilience-related themes such as car independent lifestyles, electromobility, collective passenger transport, demand management strategies, road safety, transport telematics and urban freight. This section results from hands-on experiences made by research and innovation projects related to the mentioned topics proposed for short-term and long-term measures, lessons learned and case examples, using the COVID-19 pandemic as a case study.

Key messages for crisis recovery and resilience building

- Use recovery to accelerate the transition towards sustainability and resilience – not for a return to business-as-usual
- Take quick action for change, e.g. to test innovative approaches – but maintain partnership approach, involving relevant stakeholders, citizens and partners
- Start to reflect on your urban mobility planning to plan for resilience – reassess your SUMP or create your SUMP which includes resilience
- Reassess your assumptions, processes and objectives about urban mobility planning to account for sustainable and resilience planning
- Assess the risks and vulnerabilities your mobility system is facing and account for these risks in your planning process
- Identify groups that are more vulnerable to stresses and shocks to incorporate their specific needs in your plan
- Set indicators and goals that tackle sustainability and resilience of your mobility system
- Use temporary measures as a mean to test long-term measures
- Integrate stakeholder and citizen's participation throughout your planning process and during the evaluation of temporary measures
- Promote multimodality to make your mobility system flexible, resourceful and inclusive
- Communicate with stakeholders and citizens during recovery and about your resilience vision
- Communicate with other cities to share and exchange knowledge about planning resilient and sustainable urban mobility systems

Key messages for integrating resilience into SUMP

Understanding resilience and its relation to urban mobility in your city.

1. Create an understanding of what resilience entails for your city, and what it could mean for your urban mobility system.
2. Map the kind of crises you consider to be potentially affecting your urban mobility system.
3. Describe for your city how you see the relation between the 7 principles for building resilience (reflectiveness, robustness, redundancy, flexibility, resourcefulness, inclusiveness, integration) and your urban mobility system.

Resilience and SUMP

4. If your city does not have a SUMP yet but is just in the process of kicking it off, integrate the resilience aspect and work towards that.
5. If your city already has a SUMP in place, resilient planning can still be integrated. A reflection of the SUMP, maybe considering evaluation results, public acceptance, and recent developments is possible.
6. If your city already has resilient planning and a resilience team established or even a whole planning framework in form of a separate plan, then strengthen the urban mobility aspects of such an approach.
7. Take concrete action, in line with the SUMP planning approach:
   - Set up working structures and make the initial commitment explicit
   - Assess planning requirements and collect information
   - Assess risks, vulnerabilities, and strengths
   - Forecast crisis, emergencies, and disturbances to achieve a resilient system
   - Integrate resilience into mobility vision and develop strategy and objectives with stakeholders
   - Set resilient indicators and targets
   - Select short-term and long-term measures
   - Assess and adjust short-term measures
   - Secure financing for resilient measure implementation
   - Communicate with citizens and stakeholders
   - Evaluate, optimize, and review from experience

Resilient mobility measures

8. Focus on measures that relate well to the 7 resilience principles: reflectiveness, robustness, redundancy, flexibility, resourcefulness, inclusiveness, integration.
9. Think multimodal and prioritise space-efficient modes.
10. Define short term as well as long term resilience measures.
11. Continuously monitor and evaluate the measures and be open to adapt them following evaluation

Cities need to safeguard and protect their critical transport infrastructures and assets, while also dealing with pressing chronic stresses that are related to societal issues. Cities should prepare the existing physical and digital infrastructure to be able to adapt to unforeseeable changes.

1. Section 1: Mobility planning for resilience

1.1 Resilient cities and resilient urban mobility

The notion of resilience in the context of cities moves away from traditional disaster risk management and accepts the possibility that a wide range of disruptive events may occur but are not necessarily predictable.[3] Hence, city resilience focuses on increasing – or at least securing – the performance of urban systems in the face of multiple hazards and crises, rather than preventing or solely mitigating the loss of assets due to a specific event.

A resilient city[4] is a city that:

- reduces vulnerability and exposure to natural and man-made disasters while managing to thrive.
- is prepared to identify, resist, absorb, adapt to, and recover from any shock or chronic stress while maintaining its essential functions.
- involves all stakeholders, especially citizens, in disaster risk reduction through co-creation processes.
- increases its capacity to respond to shocks and other unforeseen chronic stresses through enhanced emergency preparedness.

[3] ARUP,The Rockefeller Foundation. (2016). City Resilience Index: Understanding and Measuring City Resilience. ARUP International Development, 47. https://assets.rockefellerfoundation.org/app/uploads/20171206110244/170223_CRI-Brochure.pdf

[4] CWA 17300 (2018) City Resilience Development – Operational Guidance https://www.din.de/resource/blob/297796/8e4862e244910feb6d12d620a2b87211/cwa-17300-standards-series-flyer-data.pdf

Box 1: Definition of the concept of resilience

Resilience is a term that emerged in the 1970s to describe the capacity of a system to resist, adapt itself and transform itself to recover from a shock, absorb its consequences and maintain levels of functionality[5]. The concept of resilience is inherently linked to the concept of vulnerability. Resilience offers a comprehensive socio-technical perspective that emphasises the importance of anticipating and reducing one's vulnerability in combination with the monitoring efforts, the ability to respond to and the capacity to learn from crises[6].

According to Climate Just and the IPCC[7], building resilience needs to account for potential exposure, risks of vulnerability, the adaptive capacity of the community impacted and the existing imbalances in power distribution in that community. In addition, it is crucial to ensure that neither the impacts nor the policies and actions taken to address them exacerbate existing or create new inequalities.Alternatively, ICLEI Montréal Commitment and Strategic Vision[8] defines resilient development as a development that can "anticipate, prevent, absorb and recover from shocks and stresses, in particular, those brought about by rapid environmental, technological, social and demographic change, and to improve essential basic response structures and functions".

[5] Azolin, L. G., Rodrigues da Silva, A. N., & Pinto, N. (2020). Incorporating public transport in a methodology for assessing resilience in urban mobility. Transportation Research Part D: Transport and Environment, 85, 102386. https://doi.org/10.1016/j.trd.2020.102386

[6] Mattsson, L. G., & Jenelius, E. (2015). Vulnerability and resilience of transport systems - A discussion of recent research. Transportation Research Part A: Policy and Practice, 81, 16–34.

[7] Adapted from the IPCC (2017) Climate Just. "Using Maps to Identify Vulnerable People and Place." Climate Just, https://www.climatejust.org.uk/1-where Accessed 8 Feb. 2021

[8] ICLEI - Local Governments for Sustainability. (2018). The ICLEI Montréal Commitment and Strategic Vision 2018-2024. Bonn, Germany.

Box 2: Examples from cities with resilience strategies

Urban Resilience Strategy – Thessaloniki (Greece)[9]

Thessaloniki is a city in transformation. A port city with a long history and a population that deeply values history and culture. It has experienced significant shocks and stresses during the recent past, but despite population shifts, a devastating fire and a major earthquake, it has responded with resilience. The Resilience Strategy for 2030 is based on eight city values[10] which represent Thessaloniki's identity and will guide how the city will plan for the future.

"Our Resilient Glasgow, A City Strategy" - Glasgow (United Kingdom)[11]

Through membership of the 100 Resilient Cities[12], pioneered by the Rockefeller Foundation programme and currently the "Resilient Cities Network" (the programme's continuation), Glasgow has developed a resilience strategy. The strategy was developed based on four essential dimensions of urban resilience: health and wellbeing, economy and society, infrastructure and environment, and leadership and strategy

Living with COVID-19 Resilience Plan – Greater Manchester (United Kingdom)[13]

The "Living with COVID-19 Resilience Plan" frames Greater Manchester's response to the pandemic, capturing cross-sectoral actions, including ones for mobility, to be delivered in the next year. The plan supports the city's ability to respond to the ongoing pandemic and builds resilience in the city-region for the short- and long-term future. It seeks to be dynamic and to provide a framework for collective responses as the city continues to improve its adaptability and flexibility to new developments[14].

COVID-19 Resilience Action Plan - Izmir (Turkey)[15]

Izmir Metropolitan Municipality has published a "COVID-19 Resilience Action Plan". The municipality has been the first and only municipality in Turkey to publish its measures taken in the struggle against COVID-19 in the form of a report and integrated action plan which also addresses mobility.

[9] See ARUP, Thessaloniki Resilience Strategy, 2020, https://www.arup.com/perspectives/publications/research/section/thessaloniki-resilience-strategy

[10] Social cohesion, local identity and heritage, environmental management, health and wellbeing, youth empowerment, multistakeholder engagement, technology adaptation and economic prosperity

[11] See Resilient Glasgow, "Our Resilient Glasgow, A City Strategy", 2016 https://www.glasgow.gov.uk/CouncillorsandCommittees/viewSelectedDocument.asp?c=P62AFQDNT1Z3UTT1DX

[12] The 100 Resilient cities left the Rockafeller foundation in 2019 to become independent and known as the Resilient Cities Network, https://resilientcitiesnetwork.org/

[13] See Greater Manchester Combined Authority, Coronavirus – COVID-19, 2020, https://www.greatermanchester-ca.gov.uk/coronavirus/?domain=tracking.vuelio.co.uk

[14] Greater Manchester Combined Authority, Resilient City, 2019 https://www.greatermanchester-ca.gov.uk/what-we-do/resilience

[15] See Izmir Metropolitan Municipality. COVID-19 Resilience Action Plan. June 2020, https://www.izmir.bel.tr/CKYuklenen/dokumanlar_2020/Covid19DirenclilikEylemPlani_ENG.pdf

Resilience and sustainability are different but compatible concepts. While sustainability focuses on reducing or eliminating environmental impact and improving economic viability as well as well-being and quality of life for communities, resilience focuses on a system's ability to endure various shocks and stresses. Addressing disturbances that threaten the short- and long-term sustainability of urban mobility requires an integrated framework of various resilience-related frameworks of criteria that can assist urban planners and decision-makers in their efforts to identify areas that need work and improvement[16].

Resilience in the context of urban mobility is the capacity of a social-ecological system (i.e. a transport infrastructure network, its maintenance crew, financing arrangements, contracts etc.) to cope with disturbance. This implies the ability to respond or (re-)organise in ways that maintain the system's essential functions, identity and structure, while also allowing for adaptation, learning and transformation. A resilient transportation system is one that promotes safe, equitable and inclusive accessibility by providing sustainable, integrated, flexible and robust mobility options – during normal times and times of crisis[17]. In other words, improving resilience should include a wide variety of prevention, mitigation, and restoration activities[18].

Box 3: Definition of a crisis in the context of urban mobility resilience

A crisis, in the context of this guide, can be understood as a shock or stress that either has an impact on the functionality of the infrastructure and services and/or on people's mobility patterns. The COVID-19 pandemic has shown that there was no direct stress in the infrastructure but rather on mobility demand and patterns. Shocks, such as natural disaster, that damage infrastructure or complicate the operation of infrastructure (e.g. cyber-attacks) steer operation and attacks the functionality of mobility systems.

Cities can respond to crises by rebuilding and reacting with emergency measures to keep up the functionality of mobility, ensuring mobility and creating alternatives. Dealing with crises requires on-call actions from mobility planning and long-term perspectives to be kept in mind.

Cities could not be considered as isolated entities as there is a high level of interdependence among cities and their systems. This can lead to cascading effects, which means that crisis escalates from local to regional, national, or even international level[19]. Cities need to safeguard and protect their critical transport infrastructures and assets, while also dealing with pressing chronic stresses that are related to societal issues. Cities should prepare the existing physical and digital infrastructure to be able to adapt to unforeseeable changes.

[16] Sharifi, A., & Yamagata, Y. (2014). Resilient Urban Planning: Major Principles and Criteria. Energy Procedia, 61, 1491–1495. https://doi.org/10.1016/j.egypro.2014.12.154 All bibliographical details should go into the list of references.

[17] 100 Resilient Cities. (2015). Resilience point of view series Transport.

[18] Adam et al. (2012) in Leobons et al. (2019)

[19] CWA 17300 (2018) City Resilience Development – Operational Guidance

Box 4: The neighbourhood as spatial scale with inherent resilience benefits

The importance of people's immediate surrounding has massively increased during the COVID-19 pandemic. Many did not even commute to work at all because of home office routines or furlough arrangements. People went for more walks in their neighbourhood. Google statistics on mobility in residential areas increased up to 30%[20] and usage statistics of local parks has gone up dramatically in most countries (e.g., in Denmark by 143%)[21].

A significant number of people chose to walk or cycle to work and thus often discovered paths and areas in their neighbourhood they might otherwise have never explored. Errands for daily goods were more frequently done in the nearest retail areas rather than in large shopping centres at the outskirts of town – due to fear of infection or because of lockdown restrictions. On the downside, retailers of non-essential goods (incl. cafés, pubs, and restaurants) were hit hard by pandemic-related restrictions. However, in many cities, voucher systems and other acts of solidarity were organised by civic groups as an attempt to keep the local community intact.

The importance of social networks in people's neighbourhoods has also risen. For example, many voluntary services, also called mutual aid groups, to help with shopping, walking the dog etc. were offered on lampposts or in locally based online communities. Such social capital is a key ingredient of a robust society. In other words, a stable, socially cohesive neighbourhood is a firm foundation for resilience in times of crisis. The social and spatial qualities of a neighbourhood even have an impact on aspects of resilience, which were on few people's radars before the COVID-19 pandemic: designing neighbourhoods with open public spaces allowed for people to spend time outdoors while staying distanced and providing safe areas for children to play outside while their parents work from home.

The neighbourhood scale has another inherent resilience feature, which is simply due to the spatial proximity of most destinations. This makes it conducive for active mobility on foot or by bike, that is, independent of the functioning of large technical infrastructures or high-tech systems. In short, there is hardly anything that can break down with pedals and shoes. The natural resilience of neighbourhoods is also a result of face-to-face encounters in convivial spaces.[22]

Such characteristics of a healthy neighbourhood do not grow automatically; they must be facilitated through good planning and design. A diverse structure of interesting retailers, for example, is – to a large degree – the result of good planning. This is also true for the existence of safe, direct and pleasant footpaths, bike lanes, high streets with areas for sojourning, seating, shade, play and social interaction. Specifically related to the threat of infectious diseases is the need to provide sufficient space for social distancing. In most cases, this requires a bold rededication of space from cars, like it has happened in Berlin, Milan, Paris and Brussels. This rededication has to go hand in hand with a push in the development of alternative, sustainable mobility solutions (such as improved regional rail services, public transport or cycling infrastructure).

It is important to enabling the neighbourhood level to make such related decision and to implement them with the necessary staff and funds. However, it is clear, that many such decisions are the prerogative of central city administrations and policymakers. This is the hierarchical level of SUMP, which necessitates excellent communication, mutual understanding and complementary actions between efforts and actors on the neighbourhood and city level.

[20] COVID-19 Community Mobility Report, Google, 2021, https://www.google.com/covid19/mobility/?hl=de

[21] COVID-19 Community Mobility Report, Google, 2021, https://www.google.com/covid19/mobility/?hl=de

[22] For a related argument see Brömmelstroet et al. (2017) Travelling together alone and alone together: mobility and potential exposure to diversity. Applied Mobilities. 2, 1. Pp. 1-15.

1.2 Principles of urban mobility resilience

The City Resilience Index[23] is the first comprehensive tool that helps cities to understand and assess their resilience in a systematic, globally applicable way.

It is based on seven essential principles that characterize resilient urban systems. These principles can be adapted to the urban mobility context as a guiding framework for sustainable urban mobility processes and plans that also incorporate resilience strategies and measures.

Table 1: The 7 principles for building resilience applied to urban mobility

Principles	Resilience principle in the context of urban mobility	Explanation (not exhaustive)
Reflectiveness	Planners and policymakers should **reflect** on the inherent and ever-increasing uncertainty and changes that affect mobility systems. Mechanisms should be used to make mobility systems continuously evolve. Standards or norms should constantly be modified based on emerging evidence. As a result, stakeholders and institutions should examine and systematically learn from past experiences and leverage their learning to continuously inform future decision-making.	Monitoring the quality of mobility services and infrastructures based on key indicators allows mobility planners to **reflect on the continuous evolution of mobility systems**. For example, **monitoring bike lanes' quality, safety and commuters' awareness of cyclists and pedestrians** should complete the monitoring of bike lanes' lengths. **Taking a step back and looking at changes** in the system that may alter measures and **identify new trends** that may be worth considering.
Robustness	**Robust** mobility systems are systems that are well-conceived and constructed to withstand the impacts of disruptions and hazard events without significant damage or loss of function. A **robust** design of transport infrastructures and networks allows anticipating potential failures in mobility systems. To make a **robust** mobility system, cities should make provisions to ensure failure is predictable, safe and not disproportionate to the cause. Preventing design thresholds, cascading failure or over-reliance on a single asset is key to avoid a catastrophic collapse.	Designing urban space and the mobility systems in a manner that is **accessible and attractive for pedestrians and cyclists** and **reduces dependence on motorised transport.** Identifying the **age of transportation system infrastructure**, its expectable **remaining lifetime**, considering **wear and tear** as well as **environmental effects.** **Maintaining and improving existing infrastructures** to make them resistant to potential hazards.
Redundancy	Mobility systems are considered **redundant** if they spare capacity purposely so that they can accommodate disruption, extreme pressures or surges in demand. It is illustrated through the presence of multiple ways to achieve a given need or fulfil a particular function. **Redundancies** should be intentional, cost-effective and prioritised at a city-wide scale. They should not be an externality of inefficient design.	**Distributing infrastructure connections and overlaps** between different areas, streets, and squares, of a human scale. Providing sufficient density for accessible services by **creating street and footpath networks that allow for multiple choices.** **Creating reserves of resources and vehicles** to provide alternatives in case one element of the system fails. Also **establishing cooperation plans** with private entities or reallocation of resources (e.g. private transport operators allocating some of their fleet for emergency purposes)

[23] ARUP,The Rockefeller Foundation. City Resilience Index.

Principles	Resilience principle in the context of urban mobility	Explanation (not exhaustive)
Flexibility	Flexible mobility systems can change, evolve and adapt in response to changing circumstances. This may facilitate decentralised and modular approaches to transport infrastructure and ecosystem management. New knowledge and technologies can play a role in making mobility systems **flexible**.	**Designing flexible public spaces** can allow for variable use and accessibility with regard to changing circumstances and regardless of weather conditions or climate change. For example, changing circumstances in the demand for mobility may require the need to use public spaces as traffic spaces. Understanding the flexibility of urban mobility systems can be done by **looking at the average speed of emergency responses to an event or the number of events and inquiries handled.**
Resourcefulness	Resourcefulness implies that mobility practitioners can rapidly find different ways to achieve their goals or meet their needs under stress or in time of shocks. Investing in the capacity to anticipate future conditions, set priorities and respond is instrumental to a city' ability to restore the functionality of critical mobility systems.	**Having a plan available** to justify the prioritisation of the use of specific resources in case of extreme events. **Mobilising and coordinating wider human, financial and physical resources,** potentially under severely constrained conditions. Promoting **cooperation among institutional groups and stakeholders** can be an innovative way to contribute to resourcefulness.
Inclusiveness	To make mobility systems **inclusive**, there is a need for broad consultation and engagement of communities, especially the most vulnerable groups. Addressing the shocks or stresses faced by one sector, location, or community in isolation of others is necessary to make mobility systems resilient. An **inclusive** approach also contributes to a sense of shared ownership, solidarity and a joint vision to build urban mobility resilience.	Including local communities can be key to **identify local needs for resilience**. **Identifying the vulnerability of certain groups** in relation to certain needs can help cities create inclusive and resilient mobility systems. **Considering differences among different social groups** in terms of connectivity, daily travel distances, the time required for regular trips and to get out of the city is the first step towards inclusive mobility.
Integrated	Urban mobility systems should be **integrated** and aligned with other city systems to promote consistency in decision-making and to ensure that all investments are mutually supportive of a common outcome. They should be also integrated into the overall transport network. The **integration** of resilience should be evident within and between city systems as well as across the different scales of their operation. Exchanging information between the mobility and other urban systems enables a coordinated and rapid response to risk and emergencies through shorter feedback loops.	Promoting the **formal engagement of organisations or community groups in disaster preparedness or recovery activities** facilitates wide support of common outcomes. Creating **joint ownership of several city government policies among different agencies** helps to exchange information and data exchanges and thus to align responses across departments.

1.3 Why is it important to bring SUMP and resilience together?

To sustain urban life during crises and to reduce the vulnerability of the transportation system, planners and policymakers must ensure that all its elements are integrated, resourceful, inclusive, flexible, redundant, robust and reflective. The challenge for cities is to achieve quick, short-term responses to a crisis without compromising the long-term functioning and evolution of the urban mobility system and related strategies. In other words, the integration of resilience into the mobility planning process should prepare cities and regions better for disruptive realities while at the same time maintaining the pursuit of important policy goals such as decarbonisation.

The COVID-19 pandemic has already triggered the need for better responsiveness to such crises as listed above. It is necessary to bring SUMP and resilience together. SUMP is an essential element of the official European Union climate policy and is advocated by all European and many national governments, institutions and banks. It offers a sustainable planning framework which is particularly conducive to the integration of resilience principles. SUMP promotes the diversification of mobility systems as well as accepting and integrating different perspectives and vulnerable groups.

SUMP and related policies should be able to respond to short term emergencies as well as maintain long-term goals. Short term agility in combination with the longer-term capacity to adapt is key to avoid future crises by anticipating and preparing for the impacts of these shocks and stresses on transportation systems. The systematic planning logic behind the SUMP cycle provides exactly this: An opportunity for cities to structurally incorporate resilience into urban mobility planning.

Box 5: Sustainable Urban Mobility Planning in a nutshell

Sustainable Urban Mobility Planning is a continual planning process at the local or regional level for sustainable urban mobility to increase urban accessibility and quality of life. The process is characterised by cooperation, goal-orientation and integration.

Through the collaboration of actors and decision-makers from transport-related and other sectors, from the district to the national level, there is a coordination of activities with mobility relevance for the local and regional level. This coordination is based on sustainable mobility objectives and policies as well as on measures developed in collaboration with stakeholders.

Established working structures to support and coordinate the measure implementation process and monitoring of progress. Shared objectives and agreed mobility strategies facilitate the legitimisation of sustainable mobility solutions and lead to improved access to funding for prioritised measures.

An assessment of current and future urban mobility performance, a clear future vision with corresponding indicators and milestones, as well as an implementation plan are key elements of future SUMP development and deployment processes. SUMPs foresee the development of all transport modes in an integrated manner.

Often the SUMP process is summarised in a policy document but not necessarily. It is most important that there is a clear strategy and an arrangement for monitoring and evaluation to guide sectoral planning for the deployment processes.

Box 6: Lessons learned from the COVID-19 pandemic

COVID-19 has forced cities to react fast and to implement new transportation measures under great pressure and has revealed that a lot of cities were able to respond quickly to the emergency. The pandemic affected mobility patterns through waves of lockdowns but also challenged transport-related policymaking and resource reallocation. In the grand scheme of things, it turned out that cities were able to implement change more easily than previously thought. These examples made for some great "proofs of concept". In many cases, emergency and resilience procedures were activated. For smaller authorities with more limited staff resources, this often meant diverting staff from their normal activities to undertake priority actions and provide support to the most vulnerable members of their communities.

Explicit measures to make public transport safe were taken in Alba Iulia, Antwerp, Klaipeda, Lucca, Manchester, Platanias and many other cities. These included: enhanced cleaning and disinfection regimes of vehicles and busy/central stations, closure of waiting rooms at station, 'chess-board' seat-marking within vehicles and obligatory use of face masks. To protect drivers, screens were fitted in vehicles and access to buses was only allowed through rear doors[24].

The crisis of the COVID-19 pandemic proved that cities with a SUMP in place were better prepared, found quicker and better-coordinated responses. Brussels is one of the many good practice examples for the confection of a SUMP as it won the 2020 SUMP award. Brussels' SUMP, called "Good Move", has clear ambitious goals, which include restricting car usage, reducing the speed limit to 30km/h by 2021 and increasing the number of pedestrians. Brussels' SUMP creation process included strong stakeholder outreach, citizen participation and the implementation of "superblocks".[25] The quick response from the city to the pandemic was facilitated by the existence of the "Good Move" plan. The plan was approved before the COVID-19 outbreak and already listed priorities for interventions. The city was, therefore, able to implement some of the Good move's bicycle measures, such as 40 kilometres of extra cycle paths, as early as May as part of the COVID-19 recovery plan . Key measures implemented in Brussels during the recovery phase were as follow:

- Reducing waiting times for cyclists and pedestrians at crossings.
- Creation of cycling lanes using tactical urbanism in major streets, highways, and strategic locations.
- Cutting out transit with filtered permeability (e.g. implementing specific signs or modal filters).
- Development of a "bike for Brussels" resilient communication campaign.
- Promotion of modal split, and more particularly bike+ride initiatives, where free car parking initiatives and bicycle parking on the outskirts of Brussels were implemented to encourage citizens to leave their car on the outskirt of the city and take their back to commute inside the city.

Brussels monitored COVID-19 recovery measures through 14 permanent bicycle counters, surveys among cyclists and non-cyclists and monthly comprehensive monitoring of all traffic[26].

Facing the emergency, the Brussels municipality took some unilateral actions based on the "Good Move" plan to respond quickly to the situation, but some, such as neighbouring communes, have criticised its decisions due to the lack of consultation of local stakeholders. Some concerns were also made at the time regarding the need for further development of alternatives to car use as the measures implemented were not able to sufficiently cope with the local needs.

[24] POLIS & Rupprecht Consult - Forschung & Beratung GmbH (editors). (2020). COVID-19 SUMP Practitioner Briefing (Issue July)

[25] Depoortere, F. POLIS Conference 2020 - Good Move Goes Viral. In POLIS Network, 2020, from https://www.polisnetwork.eu/polis-conference-2020-presentations

[26] Depoortere, F. POLIS Conference 2020 - Good Move Goes Viral. In POLIS Network, 2020, from https://www.polisnetwork.eu/polis-conference-2020-presentations

Box 7: COVID-19 recovery strategy

"The European Commission has set out strategic guidance for the implementation of the Recovery and Resilience Facility in its 2021 Annual Sustainable Growth Strategy (ASGS)". "In order to benefit from the Recovery and Resilience Facility, Member States should submit their draft recovery and resilience plans outlining national investment and reform agendas in line with the aforementioned EU policy criteria".

"Based on their relevance across Member States, the very large investments required, and their potential to create jobs and growth and reap the benefits from the green and digital transitions, the Commission strongly encourages Member States to include in their plans investment and reforms in flagship areas".[27]

The following flagships can refer to urban mobility:

- "**Power up** – The frontloading of future-proof clean technologies and acceleration of the development and use of renewables".
- "**Recharge and Refuel –** The promotion of future-proof clean technologies to accelerate the use of sustainable, accessible and smart transport, charging and refuelling stations and extension of public transport".

Cities should coordinate with their national government to ensure that they benefit from the Recovery and Resilience Facility.[28]

[27] Wieczorek, Marta, and Enda McNamara. 2020. "NextGenerationEU: Commission Presents next Steps for €672.5 Billion Recovery and Resilience Facility in 2021 Annual Sustainable Growth Strategy." European Commission - European Commission. September 17, 2020. https://ec.europa.eu/commission/presscorner/detail/en/IP_20_1658

[28] Miglietta, Matteo. 2021. "A New Consultation Warns: Many EU Governments Are Excluding Regions And Cities From The Preparation Of Post-COVID Recovery Plans." European Committee Of The Regions. January 22, 2021. https://cor.europa.eu/en/news/Pages/post-COVID-recovery-plans-.aspx

1.4 Sustainable Urban Mobility Planning steps for resilient cities

The established concept of SUMP provides the ideal planning framework to develop a resilient mobility system for the short-term adaptation to crisis and the long-term sustainable urban mobility strategy.

In other words: Incorporating resilience principles into Sustainable Urban Mobility Planning helps cities to simultaneously achieve two goals:

- The long-term sustainability of mobility and transport and
- The ability of this mobility system to cope with unforeseen incidents.

To do this systematically, it is necessary to "weave" resilience thinking into the established SUMP process. This is visualised in the SUMP cycle which presents all phases, steps, and activities along the entire SUMP process. The purpose of this chapter is to highlight crucial steps for resilience planning throughout the SUMP cycle. It highlights specific resilience principles and articulates suitable methods, tools and activities on the way towards the sustainable and resilient city.

Because cities might be at very different starting points, there is no single ideal way to tackle this – it is highly dependent on the specific situation and the status of local SUMP and resilience management.

- If your city does not yet have a SUMP but is in the process of kicking it off, it is a great opportunity to also integrate the resilience aspect from the start. **This guide will offer a practical framework for such a combined approach.**

- If your city already has a SUMP in place, resilience planning can still be integrated. A reflection and update of a SUMP, considering evaluation results, public acceptance issues and recent developments is always a good idea. **The resilience focuses 1-3,5-10 and 12 (see below) will be of particular interest to you.**

- If your city already has a resilience team established or even a whole planning framework in form of a separate plan, then this guide can support the integration of mobility planning into your resilience management. Linking this higher-level strategy with your local mobility planning can be highly beneficial for ensuring a safe, sustainable and strong urban system for citizens. **The resilience focuses 1 and 5-9 will be of primary interest to you.**

The SUMP cycle is a simplified and idealised representation of the overarching SUMP planning logic, broken down into four separate phases with smaller steps within each. It has proven very helpful for planners to structure and keep track of a complex process.

The four phases are:

1. Preparation and analysis,
2. Strategy development,
3. Measure planning, and
4. Implementation and monitoring.

Depending on the local and regional situation, certain steps and activities can be adapted and skipped (if equivalent results are already available, e.g., from a related planning process) or repeated at a later stage. Such adaptation to the specific situation must be carried out by the local and regional actors themselves.

Figure 1. The 12 steps of Sustainable Urban Mobility Planning (SUMP 2.0) - A planner's overview [29]

[29] Rupprecht Consult. Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan.

For a planning cycle that also considers resilience (Figure 2), a second layer with the principles for urban mobility resilience is added around this cycle. With this combination, the result is a solid planning framework for resilient mobility planning. Combining SUMP steps and resilience principles enables cities that already have a SUMP to understand at which step certain resilience principles are most relevant. Conversely, it allows cities that already have resilience planning strategies in place to understand how to incorporate SUMP principles into their existing strategy.

Figure 2. SUMP cycle with a resilience focus

1.4.1 Preparation and Analysis

The success of the transition towards resilient urban mobility will largely depend on the degree to which resilience principles can be incorporated into the SUMP process. This requires an explicit decision, strong commitment and the declared willingness to invest time and money into the process by local governments.

This section reflects on what needs to be considered by planners and policymakers to effectively include resilience in the preparation of a SUMP and the analysis of the resilience level of their mobility systems. The first step for the initial phase is an explicit decision by policymakers to incorporate resilience in their SUMP. The groundwork for the planning process is laid by analysing which resources are available for planning and setting up appropriate working and participation structures that incorporate resilience planning. Then municipalities should analyse the local planning needs and gather information to later inform their choice in implementing measures for resilient. The final step before the development of a strategy is the assessment of risks, weaknesses and strengths of an urban mobility system to understand the city level of resilience and to adjust the SUMP accordingly.

Resilience focus 1: Set up working structures and initial commitment

Local governments are key to transportation systems, not only because they arrange public-private partnerships (PPPs) and connect stakeholders but also because they possess crucial knowledge. In addition, local governments can initiate, execute and coordinate emergency responses and bring together different actors towards joined-up risk management. Therefore, a strong and well-organised city government that communicates clearly and directly with the community is essential to build a resilient mobility system.

The initial phase of the integration of resilience into a SUMP should focus on the set-up of working structures and of a planning framework that directs available resources to defined goals, while at the same time ensuring transparency and democratic principles for resilient urban mobility planning. Traditional SUMP working structures (project coordinator, SUMP core group and steering and technical committee) may well serve this purpose; but also setting up a resilience team within the SUMP working structure may be suitable. In case a cross-sectoral resilience team already exists, it is advisable to include it in the preparation of a SUMP; otherwise, it seems sensible to establish such a team to facilitate the implementation of an integrated resilience strategy. The creation of a dedicated cross-sectoral resilience team along with the nomination of Chief Resilience Officers can take the lead. For example, across the cities surveyed by the Global Resilient Cities Network (CRCN), 87% of Chief Resilience Officers were involved in their cities' response or recovery to COVID-19[30], in addition, inter-agency collaboration promotes connected and rapid responses, which also supports the implementation of an integrated resilience plan that accounts for all city systems.

Cities have different possibilities to establish specific working groups with policy and decision-makers at the city level and councillors working on climate change adaptation and resilience. In addition, any other city stakeholder working on resilience (e.g. critical infrastructure managers, service providers, emergency services, the media, civil society associations, non-governmental organizations, academic and research institutions, consultancies, etc.). At an individual level, every local practitioner with a responsibility to plan and manage resilient mobility will have to develop new skills and competences in resilience adaptation, risk assessment, data analysis and management as described further below.

[30] Global Resilient Cities Network. (2020). Toolkit for a Resilient Recovery (Issue July)..

Box 8: Organisational change of local authorities towards resilience[31]

The SUITS project is a four-year research and innovation action to increase the capacity building of local authorities and transport stakeholders. It also aims at transferring learning to smaller sized cities to make them more effective and resilient to change in the implementation of sustainable transport measures.

The project team uses its expertise in organisational change to enable employees in local authorities to cope with the increasing expectations and requirements of a SUMP. The following eight-stage Process encapsulates the SUITS approach:

1. **Create Urgency** – Create a shared perception of the 'need' for change amongst local authorities' employees to ensure full support and identification of an "ideal" change agent with strong relationships and trust among the key decision-makers in the organisation.

2. **Form a powerful Team** – Build a coalition to support change. The team should be a role model for the wider organisation. A diverse coalition should be built from employees with a range of skills and life experiences and from different departments. In some cases, it may also be useful to expand the coalition externally to complete internal expertise.

3. **Create a Vision for Change** – The creation of a vision requires significant efforts from all those involved, e.g. mobility departments, change agent and other selected people in the local authority. The vision must be clear and easy to understand to ensure support from the whole organisation. It should last for a long time and must be 'inspirational' to have maximum effect.

4. **Communicate to buy in** – General awareness and enthusiasm must be created for the goal behind the vision. Everyone should be invited to participate, consider and suggest concrete steps that could be implemented in their workspace or organisation.

    - The vision of Alba Iulia (Romania) was communicated in various meetings/workshops/seminars organised within the different departments of the municipality by the guiding team. Most of the departments were involved in the process.

5. **Empowering broad-based action** – Empowering employees implies listening to them, investing in them through training and giving them credits for major accomplishments. Some obstacles (e.g. structure, skills, systems & supervisors) must be addressed to increase employee empowerment and engagement in the change process.

    - To improve cooperation between the various departments, the city of Stuttgart (Germany) has set up a steering committee. Representatives of the departments meet about once a month to discuss ongoing projects and to shape the cooperation.
    - As part of the change process, the West Midlands Combined Authority (United Kingdom) organizes in-house workshops with external trainers and internal workshops for staff to develop ideas for concrete activities. Employees are encouraged to share and discuss issues they have found on specific topics of sustainable mobility.

6. **Create short-term wins** – Small steps that lead to short-term success foster satisfaction, commitment and the overall spirit. Organisational change is therefore ideally initiated with concrete, target-oriented activities by the guiding team in close cooperation with senior management, leading to clear achievable results.

7. **Build on the Change** – Cities should increase their capacity to become learning organisations, which automatically increases their flexibility and resilience. A learning organisation is defined by personal mastery, mental models, shared vision, team learning and system thinking. A learning organization is constantly in motion, which allows and even encourages innovative problem-solving, organisational change and knowledge-sharing.

    - The city of Valencia changed its organisational structure from a silo-organisation to a cross-departmental project-based organisation which allows for more flexibility and innovative thinking. In such teams, individuals from different departments work together on a project basis toward a common goal.

    - The city of Rome created a specific unit under the mayor to check whether a projects' content and its effects on the public are in line with the city's and its citizens' sustainability targets. This unit demonstrates the local authority's openness to reflect their mental models, to become more innovative, flexible and citizen focused.

8. **Anchor the Changes in Corporate Culture**. For a change to be sustainable and successful it must become anchored in the local authority's corporate culture. While structural and procedural changes are mandatory to allow a LA to be turned into a learning organisation, for change to be successful and sustainable it is crucial that the need to change become anchored in the corporate culture. If the need for change becomes a fundamental principle in an organisation, this organisation can be characterized as a learning organisation with high levels of organizational capacity. To anchor changes in corporate culture, local authorities can for example foster permanent knowledge exchange within its core and with external stakeholders through cross-learning groups. To avoid a fading of the achieved success, cross-learning groups were set up between the West Midlands Combined Authority, Coventry City Council and Coventry University. These UK partners started to exchange experiences with the City of Valencia and thus learned from each other and saved time and costs in their future mobility planning.

[31] Contribution from Ann-Marie Nienaber and Andre Woodcock (Coventry University)

A broad participatory approach is key to ensure that resilience is being integrated to the benefit of all and not to the few. Effective participation of all stakeholders in their diversity allows everyone to be informed and sensitized but also to be aware of the commitments made. Therefore, it is advisable to establish an effective working structure to ensure the active participation of citizens and key stakeholders, whilst steering institutional cooperation and coordination at different levels.

Citizen participation should be a key component of different steps along the entire process, such as data collection, strategy development, measure implementation and appraisal, and monitoring. It may be instrumental beyond the decision-making phase, contributing to policy implementation and even assessment, which cannot be reduced to a simple technical process. New technologies today make citizen participation possible at different steps of the SUMP creation process, through the creation of mobile applications and electronic surveys. Ideally, a genuine participation spirit – sometimes referred to as co-creation – is deployed in every step.

Box 9: Example of cooperation between companies and a city

Engaging employers and employees in challenging times - Antwerp (Belgium)

The COVID-19 pandemic created extra mobility changes for companies, on the one hand, by contributing to the rapid increase of home-office work and remote management. On the other hand, other stakeholders, such as healthcare institutions, needed assistance to get healthcare staff to commute to work safely during the first wave in March to May 2020. With the "new normal", new working patterns have emerged along with new commuting patterns that require mobility practitioners to adapt mobility planning to reflect such changes.
For example, the Smart Ways to Antwerp (SWtA) programme helped 119 companies to develop their own smart and sustainable mobility policies. Antwerp counts over 250,000 commuters which makes employers and employees a group with a high potential for change. By working with employers, the city aims to create a network that enables participating companies to share experiences. Antwerp healthcare institutions received targeted assistance to get healthcare staff to commute to work. Furthermore, digital learning networks were set up with participating and interested companies to discuss remote working, cycling to work, using shared mobility or Mobility as a Service in a work context.

Policymakers need to ensure development and delivery under emergency conditions. To do so, you may want to consider implementing cooperation mechanisms through public-private partnerships. Working with other stakeholders will help municipalities make their mobility system resourceful, inclusive and integrated which will overall contribute to their resilience. Effective collaboration between stakeholders at various levels of the city administration, including an inter-agency collaboration that promotes connected and rapid response, ensures the development and delivery of an integrated multi-modal transport plan.

Resilience focus 2: Collect information

Once working structures are in place it is time to collect information on the resilience level of your transport systems. Such information is crucial because a resilient urban mobility system consists not only of robust physical infrastructures but also – and importantly so – of knowledge assets such as data and intelligence. This is also important for the definition of meaningful and feasible indicators, for the development of a shared vision and, later, of an evaluating and monitoring strategy. Data collection to build resilient urban mobility should go beyond the activities in the standard SUMP process by integrating external risk factors and how these risks affect transport systems differently. Recent technological advances in data collection and analysis (crowdsourcing, Big Data etc.) should be utilised for this purpose.

Box 10: Identifying vulnerable groups

The COVID-19 crisis demonstrated, along with different natural disasters before, that crises affect certain populations groups disproportionally. To counteract this danger, it is important to carefully question the universal validity of certain models and best practice examples. In addition, all vulnerable groups and their specific type of vulnerability (finances, disabilities, distance, time patterns, care obligations etc.) need to be fully understood so that equity gets systemically embedded in resilience and SUMP planning. For example, the impacts of the COVID-19 crisis on public transport systems affected frontline care workers to a particular degree. Yet, as most care workers and public transport users are women, it is clear that resilience and recovery plans have to be gender sensitive. Any type of mobility and resilience-related data should therefore always be disaggregated by gender, age-groups (to the extent possible) and other vulnerability parameters.

It is also important to identify the diversity of actors and infrastructures, their varying exposure to risk and their specific vulnerability level. This requires a detailed understanding of the mobility needs and practices of different social groups in different parts of the city to avoid that any measure might inadvertently increase their vulnerability. This knowledge should also manifest in the definition of related indicators so that the fairness of resilience measures can be ensured and monitored. The following boxes provide examples of data that can be particularly valuable for the development and execution of resilience strategies; they also include helpful suggestions about how such data can be collected.

Box 11: Technological measures to gather data to improve resilience

Origin-destination matrixes can be used to create aggregate indicators of how resilient an urban mobility system is and how it can be used in the event of major disruptions of the network.[32] [33] Integrating behaviour and mobility models can also provide additional insights into the resilience process[34].

The COVID-19 crisis has highlighted how data gave valuable insights to policymakers to shape recovery plans. Certain new technologies proved particularly valuable for the collection of data that can be used to assess and build a resilient system:

- Wireless ticketing systems across modes (and ideally across operators) facilitate access to real-time data on network capacity.
- Intelligent Transportation System, in the long run, provides continuous data collection on individual car mobility which helps municipalities to gather data and monitor data on the most relevant aspects when resources and time are limited. Besides, continuous monitoring allows for comparison in time of crisis.
- Anonymised data from mobile cellular networks can be used to observe the population's mobility. This was often used in the COVID-19 crisis to understand changing mobility flows, adapt public transport services and spatial resilience planning or to identify the most effective locations of pop-up cycling lanes.

[32] Azolin et al. Incorporating public transport in a methodology for assessing resilience in urban mobility.

[33] Martins, M. C. da M., Rodrigues da Silva, A. N., & Pinto, N. (2019). An indicator-based methodology for assessing resilience in urban mobility. Transportation Research Part D: Transport and Environment, 77(2020), 352–363. https://doi.org/10.1016/j.trd.2019.01.004

[34] Gonçalves, L. A. P. J., & Ribeiro, P. J. G. (2020). Resilience of urban transportation systems. Concept, characteristics, and methods. Journal of Transport Geography, 85(September 2019), 102727. https://doi.org/10.1016/j.jtrangeo.2020.102727

Box 12: Example of a data collection tool in Trieste, Italy[35]

In Trieste, a transport information platform[36] was developed during the CIVITAS PORTIS project, to gather and provide information, to share data and to connect public entities, stakeholders and citizens. This tool had an important role in the SUMP development. The platform's development involved different stakeholders, including the Public Works Department, the Police force and the tourism office in the local administration. Also, Trieste Trasporti (the local public transport operator), the bike-sharing operator Bicincittà and the regional Government played an important role. The platform supports mobility planners through the integration of several data sources and gives them access to information that is crucial to their work, such as traffic data and studies.

[35] Contribution from Dirk Engels (TML)

[36] See Trieste Trasporti S.P.A. 2019. "Trieste Trasporti." Trieste Trasporti S.P.A. 2019. https://www.triestetrasporti.it/.

Box 13: Example for cooperation mechanisms to collect information to build resilience in West Midlands, United Kingdom[37]

Transport for West Midlands (TfWM) liaised with West Midlands Police to use existing ANPR (Automatic Number-Plate Recognition) cameras that were originally deployed as part of tracing criminal activity. This provided TfWM with the opportunity to analyse 24/7 data on the Key Route Network and thus to get a near real-time view on the main roads in the area, which in turn facilitated more accurate traffic modelling by a transport planning team. As a result, the West Midlands Police was funded to deploy more ANPR cameras and TfWM received higher volumes of data for lower costs.

[37] Fox, D. POLIS Conference 2020 - NETWORK RESILIENCE EVOLUTION THROUGH INNOVATION. In POLIS Network. Retrieved from https://www.polisnetwork.eu/polis-conference-2020-presentations/

Resilience focus 3: Assess risks, weaknesses, and strengths

Assessing risks weaknesses and strengths is essential for a city to analyse and enhance the resilience level of their mobility system. An up-to-date risk assessment can help cities to attract funding or gather the information that will improve communication[38]. Therefore, regular risk assessments should be built into working routines; these should include various stakeholders to ensure comprehensive coverage of different perspectives.

Systematic risk assessment methods such as IVAVIA[39] (Impact and Vulnerability Analysis of Vital Infrastructures and built-up Areas) developed by the RESIN project, can be used to better understand impacts and vulnerabilities related to climate change consequences. This allows identifying adaptation measures and areas where actions are needed first.

Risk assessment tools should be easy to understand by a variety of stakeholders. However, the person addressed at first hand by risk assessment tools is the initiator, coordinator or manager of a city's overall risk-based assessment project or the person responsible for the climate change adaptation planning.

Table 2 provides an overview of different risk assessment tools that can be used in the resilience / SUMP planning process. These tools were gathered from the European Resilience Management Guidelines[40], the UN Office for Disaster Risk Reduction's work on resilience[41] and the IVAVIA guidelines[42].

Table 2: Overview of different tools for risk assessment

Tool	Purpose	Type of tool	Phase	Method	Format
Quick Risk Estimation[43]	Identify and understand current and future risks, stress, shocks and exposure threats to human and physical assets	Multi-stakeholder engagement process to establish a common understanding (not a full-scale risk assessment)	Ex-ante to develop resilience strategy Ex post for monitoring & evaluation	Uses the hazards classification outlined by the United Nations Office for Disaster Risk Reduction (UNDRR). "Produces a dashboard-style risk assessment advising the risks and hazards to human and physical assets, impacts of identified main risks and associated perils on the specified location and/or particular asset."	Spreadsheet
Risk Systemicity Questionnaire[44]	Identify and prioritize risk scenarios, showing interdependencies between risks which leads to networks of risks. Indicates level of awareness of risk	Multi-stakeholder engagement process	Ex-ante to assess exposure to risk Ex-ante to develop resilience strategy	Users are asked to consider the relative likelihood of a broad range of risks in their cities. Provides participants with a relative risk score and awareness score Presents a range of risk scenarios	Spreadsheet

[38] Terenzi, A., Latinos, V., Peleikis, J., & Porras, B. A. (2017). Transition Handbook Training Package. www.ramses-cities.; Smart Mature Resilience Project. (n.d.). European Resilience Management Guideline.

[39] Rome, E., Ullrich, O., Lückerath, D., Worst, R., Xie, J., & Bogen, M. (2018). IVAVIA: Impact and vulnerability analysis of vital infrastructures and built-up areas. https://doi.org/10.1007/978-3-030-05849-4_7

[40] Smart Mature Resilience Project. (n.d.). European Resilience Management Guideline. https://urbanresilienceforum.eu/fileadmin/user_upload/Practical_Information/Marketplace/SMR-EMRG-handbook-WWW_s.pdf

[41] UN Office for Disaster Risk Reduction, https://www.undrr.org/

[42] Resin, IVAVIA, 2018 https://resin-cities.eu/resources/ivavia/

[43] United Nations Office for Disaster Risk Reduction, Quick Risk Estimation (QRE) https://www.unisdr.org/campaign/resilientcities/toolkit/article/quick-risk-estimation-qre

[44] Smart Mature Resilience Project. (n.d.). , Risk Systemicity Questionnaire https://smr-project.eu/tools/risk-systemicity-questionnaire

Tool	Purpose	Type of tool	Phase	Method	Format
Preliminary Resilience Assessment[45]	Understand where the city stands in terms of resilience which includes an understanding of transport resilience	Analysis of the challenges and pressures	Ex-ante to develop resilience strategy Ex-post to monitor & evaluate the resilience implementation process	Enables local governments to set priorities and targets for the co-creation of the resilience strategy and the resilience action plan, as well as for monitoring progress by making use of resilience indicators	Text document
The Disaster Resilience Scorecard for Cities[46]	Provides a set of assessments that allow local governments to assess their disaster resilience at a city level.	Multi-stakeholder engagement process to establish a common understanding	Ex-ante to develop resilience strategy Ex post to monitor & evaluate the resilience implementation process	Multi-stakeholder workshops to develop indicators	Spreadsheet
Resilience Maturity Model (MM)[47]	Identify the present resilience maturity stage of the city and develop a shared understanding of the resilience-building process. Enables monitoring and evaluation of the implementation of activities towards increasing resilience maturity.	Multi-disciplinary tool that identifies policies by level of resilience, dimensions, stakeholders and subdimensions	Ex-ante to identify level of resilience Ex post to monitor & evaluate the resilience implementation process	Using 5 stages of resilience maturity based on 10 indicators	Spreadsheet
IVAVIA methodology[48]	Facilitates the understanding of climate change effects, the identification of geographical hotspots of vulnerability and risk and the assessment of likely impacts on people, economy, built-up area, vital infrastructure and other elements	Multi-disciplinary tool that utilises qualitative and quantitative information about a city's vulnerabilities and risks	Ex-ante to assess exposure to risk Ex-ante to identify indicators Ex-ante to aggregating vulnerability components to risk	Consists of seven modules that allow a qualitative, comprehensive and quantitative assessment and how to best present the outcomes to your stakeholders	Software tools

[45] United Nation Office for Disaster Risk Reduction, (2017), Disaster Resilience Scorecard for cities, Preliminary level assessment https://www.unisdr.org/campaign/resilientcities/assets/toolkit/Scorecard/UNDRR_Disaster%20resilience%20%20scorecard%20for%20cities_Preliminary_English.pdf

[46] United Nation Office for Disaster Risk Reduction, Disaster Resilience Scorecard for Cities https://www.unisdr.org/campaign/resilientcities/toolkit/article/disaster-resilience-scorecard-for-cities

[47] Smart Mature Resilience Project. (n.d.). , Resilience Maturity Model https://smr-project.eu/tools/maturity-model-guide/

[48] Resin, IVAVIA, 2018 https://resin-cities.eu/resources/ivavia/

Tool	Purpose	Type of tool	Phase	Method	Format
The City Resilience Profiling Tool (CRPT)[49]	Provides a cross-cutting diagnostic for resilience-based urban development. Generates metrics for urban resilience to establish a baseline that covers the entire urban system's weaknesses, vulnerabilities and strengths. Useful to develop concrete and prioritised actions to plan-out risk and build-in resilience	Multi-sectoral, multi-shocks and stresses and multi-scale approach	Ex-ante to assess exposure to risk Ex-ante to develop resilience strategy	Provides a framework to evaluate urban resilience and develop actions for resilience tailored to the city using a diagnostic methodology	UN-Habitat software

1.4.2 Strategy Development

The goal of this second phase is to define the strategic direction for incorporating resilience in a SUMP in cooperation with citizens and stakeholders. In this phase, a future resilient urban mobility vision and strategy for the Functional Urban Area is developed, based on the previous analysis work, forecasting and the development of future scenarios. The vision both aim towards preventing and mitigating risks as well as strengthening the economic, social and climate resilience. In this phase, resilient urban mobility indicators and targets are developed as they have the potential to set clear standards for your SUMP implementation and allow for a comprehensive evaluation and impact assessment.

Resilience focus 4: Forecast crisis, emergencies and disturbances to achieve a resilient system

During the initial phase of strategy development, it is advisable to consider a city's potential future mobility conditions, in relation to the different risks and vulnerabilities identified during the previous phase. It is also important to look at the various possible scenarios and then to compare the benefits and threats against each other. "Scenarios try to capture the scope of uncertainty that comes with "looking into the future" to have a better factual basis for strategic decisions".[50]

The COVID-19 crisis has been a defining event in many ways for mobility, but more so by providing a severe test of public transport operators' resilience. Many had to realise that traditional static risk-registered crisis management and business resilience approaches were inadequate to the pace and scale of the COVID-19 recovery needs[51]. We can therefore conclude that it is important to imagine and forecast – as much as possible – all kinds of different crises as a starting point for any resilience planning.

Scenario development is one way to forecast crises, emergencies and disturbances. Scenarios are not intended to be accurate predictions about how the future may unfold but rather provide a means of better understanding and working with this uncertainty by highlighting possible futures. Interactive maps and data viewers can support municipalities in the construction and selection of scenarios. The combination of SUMP and resilience planning goes far beyond traditional scenario planning because a deliberate effort must be spent to think about risk and vulnerability scenarios. Therefore, in addition to a business-as-usual (BAU) scenario and low carbon scenarios, resilience forecasting requires to imagine worst-case scenarios, and sometimes seemingly absurd scenarios and to brainstorm about suitable responses. These later scenarios could then be assessed against the BAU scenario to formulate an optimal scenario for meeting a SUMP vision and objectives.

[49] UN Habitat. City Resilience Profiling Tool Guide. 2018, http://urbanresiliencehub.org/wp-content/uploads/2018/02/CRPT-Guide.pdf

[50] Rupprecht Consult. Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan.

[51] Van Audenhove, F.-J., Rominger, G., Eagar, R., Pourbaix, J., Dommergues, E., & Carlier, J. (2020). The future of mobility. In Arthur D. Little future Lab & UITP (Vol. 120, Issue 4th).

Experience shows that at least two projections are advisable: Climate change projections and urban development projections (i.e. considering potential future urban development that could be implemented in your city in your scenario).

Other planning scenarios are worth taking a look at in the context of resilience planning such as the recovery scenario planning and business continuity planning[52] .

- Recovery scenario planning identifies key macro uncertainties. It defines a set of potential future realities to assess their impacts and prepare strategic and operational responses.
- Business continuity planning allows municipalities to find processes and ways of working to be readily adapted during the crisis to deliver required outcomes until the return to normal[53].

The use of a validated urban and transport management tools, such as origin-destination matrixes, can be used for forecasting as well. Also, certain risk assessment tools (see table 2 page 25) are valuable for forecasting and scenario building. In addition, the "Sub-seasonal to Seasonal Forecasting" method deserves specific mention.

Table 3: Sub-seasonal to Seasonal Forecasting

Tool	Purpose	Methodology	Format
Sub seasonal to Seasonal Forecasting[54]	Convergence between weather prediction and climate forecasting by putting weather and climate on a continuum of time and space scales. Inform and enable decision-makers in transportation to reduce society's vulnerability to weather, climate and other environmental variabilities	Using weather and climate data, this forecasting tool allows to foresee an incident in a window of 2 to 12 months	Map rooms

Resilience focus 5: Integrate resilience into mobility vision and develop objectives with stakeholders

Setting a vision, building on scenarios, clarifies the priorities of a city and is an important ingredient of SUMP. Using these elements strategically can reinforce the integration of SUMP as it allows to re-imagine a new future for cities with more robust, inclusive, reflective, redundant, flexible, resourceful and integrated transportation systems. During the development of a positive vision, it is essential to differentiate between immediate and long-term goals. This helps to be clear and explicit in the prioritisation of actions for urgent recovery vis-à-vis long-term transformational change.

A current crisis can be a starting point to develop, review or change an ongoing SUMP planning process towards the desired future. Interestingly, cities that already had well-articulated urban mobility visions and plans with support from local governments[55] tended to cope better with the pandemic; in fact, many of them used this time of crisis as an opportunity to further change and update their mobility plans.

The development of an overarching long-term resilient mobility vision works best with the involvement and empowerment of relevant stakeholders across all relevant urban policy domains. This includes mass transit operators, representatives from businesses, associations, public agencies, academia and civil society.

[52] Rome et al. IVAVIA: Impact and vulnerability analysis of vital infrastructures and built-up areas.

[53] Van Audenhove et al. The future of mobility.

[54] Robertson, A., & Vitart, F. (2018). Sub-seasonal to Seasonal Prediction - 1st Edition (F. Vitart & A. Robertson (eds.); 1st Edition). Elsevier. https://www.elsevier.com/books/sub-seasonal-to-seasonal-prediction/robertson/978-0-12-811714-9

[55] Van Audenhove et al. The future of mobility.).

14: Example of a resilient urban mobility vision and strategy

Resilient urban mobility vision – Thessaloniki (Greece)[56]

Thessaloniki has developed a Smart and Resilient Mobility Plan, based on meteorological scenarios and the national adaptation plan for climate change. Climate change is expected to negatively impact Thessaloniki's transport system, either through direct effects on the built environment or through indirect effects linked to adaptation measures. The city has developed a strategy to prioritize measures, policies and actions to reduce transportation systems vulnerability, increase their resilience and secure safe-proof investments. Thessaloniki's resilience vision focuses on cooperation between authorities, the development of monitoring systems, data collection, revision of the design specifications of current transport infrastructure, use of 'smart' technologies and systems and the promotion of the use of energy-efficient vehicles.

[56] See Chrysostomou, K. Smart and Resilient Urban Mobility Planning in Thessaloniki. 2015. In CIVITAS - Cleaner and Better Transport in Cities. Retrieved, from https://civitas.eu/content/civitas-wiki-pre-sgv-smart-and-resilient-urban-mobility-planning-thessaloniki

Figure 14 of the SUMP Guidelines provide specific recommendations on how to work with stakeholders at different levels of government[57]. The participatory "co-creation" of such a strategy harnesses the knowledge and ideas from many different angles and reinforces the strategy's acceptability, adaptability, innovation and robustness[58]. The resulting feeling of co-ownership increases the likeliness of effective implementation. In doing so, you will be able to ensure the integrated nature of your strategy along with the regulation of the integration of resilience at the system-level.

A good resilience strategy thus includes proposals by stakeholders but at the same time has to be concrete and achievable. To develop a vision and strategy cities should identify their resilience priorities, options and opportunities as well as barriers and drivers. Cities should also incorporate mainstream resilience into key existing strategies, action plans and frameworks.

For this step, it is not necessary to reinvent the wheel as certain tools (table 4) exist that provide guidance for the development of a resilience strategy. As mentioned above, a resilient mobility strategy has to consider the specific situation of vulnerable groups and has to include related specific measures. It is essential to embed equity in system recovery.

Table 4: Strategy building tools

Tool	Purpose	Methodology	Format
Resilience Information Portal (RIP)[59]	Used to create the necessary momentum for the expected release and adoption of the resilience strategy among citizens, reinforce the importance of resilience-building process and achieve the necessary political commitment	Allows cities to internally or publicly display data that is already available to the city as it applies to resilience, vulnerability and crisis	Online website
Resilience Building Policy tool (RBP)[60]	Database of good practices from European cities, along with information about what worked or not in the implementation of similar policies.	It is an extension of the Resilience Maturity Model (see table 2).	Online website

[57] Rupprecht Consult.. Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan.

[58] Cambien, A., & Beausurez, N. (2020). La Boussole de la Résilience.

[59] Smart Mature Resilience Project. (n.d.). , Resilience Information Portal, http://smr-project-test.appspot.com/main.page

[60] CEN WS 17300: 2018. City Resilience Development.

Box 15: Example of an inclusive mobility strategy in Guadalajara, Mexico[61]

The Metropolitan Area of Guadalajara has implemented various measures in the context of the COVID-19 crisis, such as pop-up bicycle lanes, promoting the use of bicycles, sanitizing the units of the public bicycle system. Steps were also taken to provide free and safe daily transportation to all people who work in the health sector. In addition, provisional transportation was organised for women and girls who, due to their gender, risk greater vulnerability in public space and their transfers, due to modifications to the operation of conventional public transport.

Figure 3. Medical Connection expands its service in response to restrictions on public transportation in the Metropolitan Area of Guadalajara.

Source: Secretaría de Transporte. Coordinación General de Gestión del Territorio

At the metropolitan level, the Metropolitan Planning Institute (IMEPLAN) plays a fundamental role in contributing to local resilience, through strategies such as the Metropolitan Risk Atlas, whose objective is to identify dangers, vulnerabilities and risks to improve future city planning. This led to the inclusion of comprehensive risk management issues in the Comprehensive Plan for Sustainable Urban Mobility (SUMP) of the metropolis.

[61] Contribution from Miriam Monterrubio Hernandez (GIZ Advisor for EUROCLIMA+)

Resilience focus 6: Set resilient indicators and targets

All cities that develop a SUMP in compliance with the European SUMP Guidelines are challenged to deal with data and indicators that are relevant for social, economic and ecological sustainability. The same applies to the development of a SUMP with an explicit resilience focus. Good indicators are suitable to quantify those aspects of the mobility system that are key to the achievement of a sustainable and resilient vision. Indicators that relate to the need for infrastructure and network development are of particular importance because they draw attention to necessary decisions about short- and/or long-term policies, measures and related budgets. This includes, for examples, indicators on the energy efficiency of public transport vehicles or the integration of multimodal solutions. These indicators can help in prioritising infrastructure measures, managing traffic, analysing mass transit options, providing resilient conditions for walking and cycling etc. Of course, these indicators will later be crucial to monitor and evaluate the efficiency and effectiveness of the implemented measures.

Although suitable indicators have to be locally specific, there are existing sets of indicators, which can inspire – and which facilitate cross-city comparisons and benchmarking. The CIVITAS and SUMI indicator sets deserve particular mention.

Box 16: CIVITAS Initiative indicators

As part of the CIVITAS impact and process evaluation framework[62], a set of indicators was developed to capture and evaluate the changes triggered by mobility-related measures in six main impact categories:

- Society - governance
- Society - people
- The transport system
- Energy
- Economy
- Environment

Each indicator is defined, explained and comes with recommendations about data collection. These indicators are used already by many cities to keep transparent track of their mobility system and the links to other domains, to monitor their general mobility evolution and to evaluate the impact of mobility-related measures.

[62] Engels, D. (2017). Support Action Towards Evaluation, Learning, Local Innovation, Transfer & Excellence. CIVITAS SATELLITE. http://www.rupprecht-consult.eu/uploads/tx_rupprecht/Refined_CIVITAS_process_and_impact_evaluation_framework.pdf

Box 17: Sustainable Urban Mobility Indicators – SUMI

To overcome existing barriers and accelerate the uptake of high-quality SUMPs Europe-wide, the European Commission pursues the idea of a common EU-framework for sustainable urban mobility indicators (SUMI).[63]
SUMI offers a tool to evaluate the effectiveness of implemented measures and policies, to compare a city's progress over time, as well as to compare with and benchmark against other EU cities. An indicator set that was originally developed by the World Business Council for Sustainable Development (WBCSD), provided the starting point for the SUMI consortium, which tailored it to the European context. The indicator set, composed of 19 indicators, was extensively tested in 46 European urban areas and covers all major policy areas[64].

SUMI Core Indicators:

- Affordability of public transport for the poorest group
- Accessibility for mobility-impaired groups
- Air pollutant emissions
- Noise hindrance
- Road deaths
- Access to mobility services
- Emissions of greenhouse gases
- Congestion and delays
- Energy efficiency
- Opportunity for active mobility
- Multimodal integration
- Satisfaction with public transport
- Traffic safety active modes
- Modal split

The SUMI indicator set is available at https://ec.europa.eu/transport/themes/urban/urban_mobility/sumi_en

[63] Finger, M., Serafimova, T., Towards a common European framework for sustainable urban mobility indicators, Policy Briefs, 2020/39, Florence School of Regulation, Transport Retrieved from Cadmus, European University Institute Research Repository, at: https://hdl.handle.net/1814/68840

[64] The indicator set needs to be further future-proofed and adapted to the rapidly evolving urban mobility technologies (e.g., electrification, automatisation and digitalisation), as well as to changing travel habits. The COVID-19 crisis serves as a reminder of how quickly urban mobility systems and environments can transform. The indicator set needs to reflect this reality and be able to consider changing demand, behaviour and technologies.

Although the CIVITAS and SUMI indicator sets capture certain aspects of a city's mobility system that are of massive importance for its vulnerability and resilience situation, both of them address these aspects by implication only. If a city faces specific hazards and risks (nearly all cities do), it is important to develop such locally specific and explicit resilience indicators.

Certain tools are available to help cities determine their set of resilience indicators. For example, the norms ISO 37120[65] and ISO 37123[66] establish methodologies for a set of indicators to steer and measure the performance of city services and quality of life. It follows the principles set out in ISO 37101[67] and can be used in conjunction with it. The CEN Workshop Agreement (CWA) 17300:2018[68] defines an operational framework for cities which provides guidance on local resilience planning.

There are two general types of resilience indicators: process-based indicators monitor the progress in the implementation of adaptation measures and the progression in the different steps of an adaptation management system whereas outcome-based indicators are suitable to measure the effectiveness of adaptation policies and activities[69].

Several documents provide assistance for the development of urban resilience indicators that can also be used in conjunction with the SUMP process (Table 5). These indicators apply to any city, municipality or local government that undertake to measure its resilience performance.

[65] ISO 37120 "defines and establishes methodologies for a set of indicators to steer and measure the performance of city services and quality of life. It follows the principles set out in ISO 37101 and can be used in conjunction with ISO 37101 and other strategic frameworks." See ISO - Organisation for Standardisation. "ISO 37120:2018 Sustainable Cities and Communities - Indicators for City Services and Quality of Life." ISO, 2018, https://www.iso.org/standard/68498.html

[66] ISO 37123:2019 "defines and establishes definitions and methodologies for a set of indicators on resilience in cities. It is applicable to any city, municipality or local government that undertakes to measure its performance in a comparable and verifiable manner, irrespective of size or location".See ---. "ISO 37123:2019 Sustainable Cities and Communities — Indicators for Resilient Cities." ISO, 2019, https://www.iso.org/standard/70428.html

[67] "ISO 37101:2016 institutes establishes for a management system for sustainable development in communities, including cities, using a holistic approach, with a view to ensuring consistency with the sustainable development policy of communities". See ---. "ISO 37101:2016 Sustainable Development in Communities — Management System for Sustainable Development — Requirements with Guidance for Us." ISO, 2016, https://www.iso.org/standard/61885.html

[68] The City Resilience Development standards series intends to support cities in becoming more resilient against various kinds of threats. The series consists of the following three CEN Workshop Agreements: Operational Guidance, Maturity Model and Information Portal. See CWA 17300 (2018) City Resilience Development – Operational Guidance https://www.din.de/resource/blob/297796/8e4862e244910feb6d12d620a2b87211/cwa-17300-standards-series-flyer-data.pdf

[69] Terenzi et al. Transition Handbook Training Package

Table 5: Resilient City Indicators

Source	Type of Indicators
IVAVIA Guidelines from the RESIN project[70]	60 indicators divided into **vulnerability type** (climatic, socio-economic, physical & environmental), **impact sectors** (building, transport, energy, water, waste, ICT, land use planning, civil protection, emergency, health, environment & biodiversity, tourism, other), **outcomes** (buildings, transport, energy, water, waste, ICT, land use planning, environment & biodiversity, agriculture & forestry, tourism, other)
Green City Action Plan Methodology[71]	The Green City Action Plan Methodology sets specific **pressure and response indicators** for all city sectors, including transport, and provides benchmark results per indicators for cities to compare themselves to.
Climate Impact Indicators by CLIPC[72]	The Climate impact indicator toolkit is based on a map viewer with an OpenStreetMap base map of Europe. Several **climate indicators** are developed and categorized by ecosystems, oceans & coasts, precipitation & floods, settlements, temperature, external. It provides cities vulnerable to natural and climate-related stresses with the first base of climate indicators.

1.4.3 Measure Planning

In the third phase, the planning process moves from the strategic to the operational level by identifying and selecting concrete measures. After concrete goals have been defined municipalities should seek the development of an actionable strategy with a clear allocation of responsibilities, liabilities, etc. This is important because different measures fall into the remit of all kinds of different actors: City administration, transport operators, transport authorities, labour unions, civic organisations and all kinds of other groups.

In a preventative situation, these measures should contribute to the agreed vision, targets and objectives. In a crisis situation, they should be suitable as immediate response and at the same time contribute to long-term goals; or at least not counteract them. Not only new measures can be selected to be part of the measure list, but also ones that were implemented in previous emergencies can be taken up and appraised to become permanent long-term measures. The most common example might be pop-up bike lanes that were implemented during the COVID-19 pandemic and became permanent after positive evaluation results. Making them part of the measure selection process can help to add them to a planning framework, select the appropriate monitoring indicators and secure their financing and funding. Risk assessments, through the general assessment of all possible measures, also support resilient measures selection and future-proof these.

Resilience planning requires holistic modifications to the transport system, which need reliable financial and staff resources as well as sufficient funds for emergency and recovery phases. Resilience planning requires holistic

[70] Rome et al. IVAVIA Guidelines – Appendix.

[71] Aligned with ICLEI's Green Climate Cities and Nature Pathway planning cycles, but also ICLEI's integrated management cycle that has been adapted for the development of the EBRD Green City Action Plan methodology in 2016 and is offered as a systematic and achievable way for cities and communities to plan and act. See Annex 2 & 3 p25-42 for the pressure and response indicators, OECD, & ICLEI. (2016). Green City Action Plan Methodology.

[72] CLIPC - Indicator Toolkit. (n.d.). Climate Information Portal. http://www.clipc.eu/indicator-toolkit

modifications to the transport system, which need reliable financial and staff resources as well as sufficient funds for emergency and recovery phases. These resources have to be embedded in a robust action plan with clear timing, responsibilities, implementation priorities and explicit awareness of interdependencies and risks. The measure planning phase concludes with the preparation of the implementation phase and the finalisation of the plan for its adaption by the appropriate political body. Section 2 (starting with page 40) provides more detailed information about different short-term measures to boost resilience.

Resilience focus 7: Select short-term and long-term measures

The COVID-19 crisis has revealed more than ever that cities should be flexible in their SUMP measure selection because special circumstances require special and sometimes very quick responses. The need for social distancing for example required fast adjustments to the urban space and public transport.

Box 18: Using tactical urbanism to implement short-term measures

Tactical urbanism is "an approach to neighbourhood building and activation using short-term, low-cost, and scalable interventions and policies".[73] It has gained popularity during the COVID-19 crisis, as a form of low-cost, low-planning and quick-to-implement intervention with the potential to significantly improve the quality of public space. It is the umbrella term for a broad range of solutions like the reallocation or adornment of public space, simple improvements to transport infrastructure or regulatory change such as repurposing parking space for outdoor restaurants), pop-up bicycle infrastructure, public transport prioritisation and pedestrianised streets, pavement widening, reduced road speeds, etc. As a practitioner, you may consider reinforcing the robustness and integration of urban transportation systems by using the flexibility of urban mobility services (e.g., using temporary unused bus shuttle to transport care workers to health facilities). Also, third parties and private service providers can play an important role. For example, some cities have permitted the use of electric scooters to improve multimodality while ensuring social distancing. Section 2 (starting with page 40) of this guide offers further recommendations for short term and long-term measures focussed on different areas and transport modes.

[73] Lydon & Garcia. "Tactical Urbanism - Short-Term Action for Long-Term Change." Island Press, 2015, https://islandpress.org/books/tactical-urbanism.

In this sense, planners and policymakers can take crises as opportunities to accelerate changes that are compatible with long-term goals, thus generating long-lasting benefits. Temporary measures to test new forms of mobility can therefore lay the foundations for bold moves towards permanent measures, but without abandoning the partnership approach and consultation, in the (near) future.

The selected emergency measures ideally facilitate structural, cultural and behavioural changes. If supported and stabilised through complementary measures, emergency measures have the potential to contribute to the intended long-term strategic change by testing out measures before their long-term implementation. Arup[74] identified six focus areas for local governments to achieve long-term change from temporary measures:

- **Engagement** with local community, vulnerable groups and governments to set clear objectives and a range of methods in an iterative way.
- **Design** for different phases of recovery to promote maximum benefits, safety and long-term behavioural change.
- **Making the case** using community, data, evidence and overall community support while ensuring local measurements.
- **Approvals** for existing and community-supported schemes, solutions to known problems and changing the rules.
- **Delivery** should be affordable, quick, inclusive, flexible, creative, practical, visible, clear, clean and safe.
- **Measurement** to gather data on safety, comfort, experience, culture and activity.

Resilience focus 8: Assess and adjust short-term measures

Selecting and implementing temporary measures and monitoring their impact during crises (or e.g., during the summer holidays and weekends) can encourage cities to first test out measures at a small scale with low-cost and unobtrusive infrastructures. It is good practice to involve stakeholders in the evaluating of such measures such as citizens, transport operators and local businesses to either adjust, endorse, or revoke their implementation in the long-term. When assessing short-term measures, it

[74] Carmichael, J. (2020). Tactical Urbanism (Issue July). https://www.arup.com/perspectives/publications/research/section/tactical-urbanism

is helpful to refer back to the risks assessment results and the selected resilience indicators.

The assessment of short-term measures should be an integral part of the implementation. The level of public awareness and acceptance thereby deserves specific attention because these two aspects greatly influence the legitimacy and long-term prospect of temporary measures. The momentum generated by some temporary measures should only be converted into permanent changes after a robust and positive evaluation. Therefore, it should be noted that evaluation should be straightforward and uncomplicated to quickly deliver a basis for intermediate decisions and to avoid that pilots are ended before their impacts (positive and negative) are known. What can be admittedly difficult is a lack of baseline data (i.e., data about the "before" situation to which any effects can be compared) and frequent changes in the speed and severity of the crisis as such (e.g. rapidly changing infection rates).

It is recommended to spend more effort on collecting the opinions of users and stakeholders (user groups, service providers and representatives of activities) on the new short-term mobility changes. With a good balance of the types of users and stakeholders, a solid understanding of the pros and cons of the measure can be built up.

Reviewing the status and impact of temporary measures can be done with the help of third parties and local businesses, university students, community surveys or with the assistance of volunteers. A role for such groups encourages cooperation and contributes to resilience planning by increasing the diversity, robustness and increases acceptance of resilience measures. Overall, the use of new technologies in resilience planning (e.g. crowdsourced data through smartphones of volunteers, data from navigation system providers etc.) allows for constant monitoring and data collections that can be employed for the evaluation of short-term measures to potentially make them permanent.

Box 19: Examples for monitoring and quick appraisal of short-term measures

FURNISH-Fast Urban Responses for New Inclusive Spaces and Habitat

The EU funded project FURNISH[75] used principles of tactical urbanism to reconfigure a street by expanding the space for pedestrians and leisure activities with the help of residents who developed, built and deployed various prototype objects in their neighbourhood. All seven FURNISH teams also pursued a real-time evaluation approach to immediately document and analyse people's reactions to their tactical interventions.

Extension of sidewalks to allow physical distancing in the city of Antofagasta, Chile[76]

The coronavirus pandemic hit Antofagasta hard but the pedestrian activity in the city centre remained high due to its strong retail basis. As the city centre became a potential hotspot of infections, the authorities decided to widen the sidewalks to facilitate distance between passers-by. Beyond its health success, the project also made it possible to test the public perception of this type of action, since the authorities are interested in creating permanent changes, discouraging the use of private cars, by offering attractive alternatives, and paving the way towards the pedestrianization of the city centre.

Quick scan approach of temporary cycling and pedestrian measures in Flanders developed by Fietsberaad Flanders[77]

The Flemish 'Fietsberaad' launched a quick-scan approach to understand the value of temporary (pop-up) measures. Its results served as a robust basis for decisions whether such measures should be consolidated, upscaled, changed, cancelled or put on hold until a moment when specific factors are fulfilled. This approach includes the following steps:

1. Selection of only the most relevant aspects to be assessed. Relevant categories included impacts on walking, cycling, the usage of buses, trams and cars, safety, air quality and local economy.
2. Observations by the mobility department with a qualitative appraisal and limited counts of the number of pedestrians, cyclists, public transport users and cars on carefully chosen locations and moments.
3. Survey among passing cyclists, pedestrians, public transport users at stops and car drivers at parking areas.
4. Survey of visitors at activity hubs such as offices or shops.
5. Interviews of main stakeholders: service providers, user representatives and business representatives.
6. Synthesis per relevant aspect
7. Recommendation on whether to maintain the measure, optimise it, implement it elsewhere, or abandon it.

Depending on the complexity of the measure and the context, and considering the resources and time, some steps can be skipped or limited. But the structuring of the aspects and the available knowledge should explicitly be discussed to maintain well-balanced documentation and motivation of choices.

[75] EIT Urban Mobility. (2020). EIT Urban Mobility COVID-19 Crisis Response call Selected projects.

[76] Contribution from Pablo Juica (GIZ Advisor for EUROCLIMA+)

[77] Contribution from Dirk Engels (TML); 'Evaluate your temporary cycling infrastructure' "Webinar 'Evalueer Je Tijdelijke Fietsinfrastructuur - COVID-19' - Fietsberaad Vlaanderen." Fietsberaad Vlaanderen, 2020, https://fietsberaad.be/nieuws/webinar-evalueer-je-tijdelijke-fietsinfrastructuur/

Resilience focus 9: Secure financing and funding for resilient measure implementation

Transitioning to a resilient mobility system can come at a high price, which can require innovative revenue generation models or changing priorities in the city budget. The costs of making mobility systems resilient are likely to increase if risks and threats require new investments. It is therefore advisable to consider funding options early on. Costs for specific urban mobility resilience measures could be covered by a variety of sources, including user fees, local taxes and charges, private funds, multilateral assistance and public subsidy[78]. A fiscal strategy, however, requires coordination with the national government. Additionally, non-traditional funding sources, such as external donor grants, private-sector financing and crowdsourcing funding should be explored. Policymakers may use revenues from these sources to either finance a project or fund new initiatives to access funding from bank loans or private finance mechanisms[79].

One of the funding sources to implement resilience measures are public transport revenues. This ensures that the beneficiaries of system improvements are the same that contribute to their funding in line with the 'user pays' principle. While user fees and taxes may not cover the full capital and operational costs, they can secure the long-term sustainability of the transport system. New technologies can also mobilise innovative funding sources (e.g., crowd-funding campaigns conducted via the internet), by contributing to the robustness of the system, which – if combined with behavioural incentives to travellers – can contribute to funding requirements. Vehicle-to-grid technologies, for example, can make the grid more resilient by contributing to the increase of supply, the creation of system capacity at time peak demand and the provision of flexible means of storage.[80] Dynamic parking, by varying the price of parking fees depending on the varying demand for parking space over time, may also contribute to further funding, some examples of such sources can also be found on page 130 of the SUMP Guidelines[81]. Other sources of funding are available at national and international scales which often require financial and strategic coordination between the local, regional, and national scale to secure funding.

Table 6: Example of funding Initiatives[82]

Name	Description
European Investment Bank – Economic Resilience Initiative (ERI)	Launched in 2016, ERI is part of the European Union's response to the challenges in the so-called Southern Neighbourhood and Western Balkans, such as forced displacement and migration, economic downturns, political crises, droughts and flooding. ERI invests in key infrastructure and private sector development. ERI offers a package of loans and innovative financial products while blending funds from the donor community with financing from the European Investment Bank[83].
European Investment Bank – Natural Capital Financing Facility	The European Investment Bank (EIB) and the European Commission have partnered to create the Natural Capital Financing Facility (NCFF), a financial instrument that supports projects delivering on biodiversity and climate adaptation through tailored loans and investments, backed by an EU guarantee, and to build resilient cities and regions[84].
European Bank for Reconstruction and Development (EBRD)– COVID-19 Solidarity Package	The EBRD has approved a comprehensive series of response and recovery measures that will significantly enhance their Solidarity Package, first unveiled on 13 March 2020, and provide support with €21 billion until **the end of 2021**. A central pillar of the Solidarity Package is a Resilience Framework providing finance to meet the short-term liquidity and working capital needs of existing clients[85].

1.4.4 Implementation and Monitoring

At this final stage of the process, the implementation of concrete actions and measures is being executed. The implementation is usually not performed by the SUMP or resilience team, but by the responsible departments. Therefore, a good handover and effective coordination of all implementation activities by the core team is important to ensure a coherent approach. Communication of selected measure packages and engagement with citizens and stakeholders is key to ensure integrated, reflective and inclusive implementation.

Using concrete institutional restructuring such as organisational changes can be core elements but tend to go unnoticed by the public. But sometimes, action implementation can directly affect the wider public, making changes visible and creating a high degree of public interest. Therefore, the public should be informed regularly and openly. Further in-depth analysis such as feasibility studies can be commissioned, and tenders for planning and construction measures can be prepared. The arrangement of continuous monitoring of the measures ensures their efficiency, supports the regular reflection and contributes to a higher quality of implementation.

Resilience focus 10: Communicate with citizens and stakeholders

Communication in times of crisis must be coordinated, frequent, transparent and clear. Professional communication is also valuable as a mean to improve passenger capacity in the public transport network (e.g. real-time information about free seats on trams), provide real-time information about safety measures and traffic and inform travelling passengers about security measures.

Communication technologies enable transport operators and municipalities to provide detailed, real-time information to travellers about the conditions on the network but also provide possible alternative routes through route planning and timetabling advice across multiple nodes to optimise the system's passenger capacity. As a policymaker, you may consider establishing clear structures and lines for public communication to facilitate smooth measure implementation, reassure commuters and maintain confidence in the transport system. Your communication strategy should include the transport department along with other departments relevant to the type of crisis such as planning, land use, etc. Besides, communication needs to be high frequency and personalized based on a good understanding of commuters needs and mobility behaviour, especially regarding vulnerable groups. By increasing access to travel information and services, individuals are better prepared to make decisions that change the transport system.

Communication is also used to inform citizens and stakeholders about the implementation of measures. may want to emphasise the positive change the measures can contribute to and their role in resilience. If possible, use quantifiable evidence of expected benefits and attractive visual elements, such as before-after pictures from other cities.

[78] Siemens, & Arup. (2013). Resilient Urban Mobility. https://www.arup.com/-/media/arup/files/publications/r/resilient_urban_mobility_a_case_study_of_integrated_transport_in_ho_chi_minh_city.pdf

[79] Siemens, & Arup. Resilient Urban Mobility.

[80] Siemens, & Arup. Resilient Urban Mobility.

[81] Rupprecht Consult. Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan.

[82] See p 131 of the SUMP Guidelines for a detailed list of possible funding opportunities. Rupprecht Consult - Forschung & Beratung GmbH (editor), 2019. Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan, Second Edition

[83] European Investment Bank, The EIB's Resilience Initiative https://www.eib.org/en/about/initiatives/resilience-initiative/index.htm

[84] European Investment Bank, Natural Capital Financing Facility; Boosting investment for biodiversity and nature-based adaptation to climate https://www.eib.org/en/products/mandates-partnerships/ncff/index.htm

[85] European Investment Bank, Natural Capital Financing Facility; Boosting investment for biodiversity and nature-based adaptation to climate https://www.eib.org/en/products/mandates-partnerships/ncff/index.htm

Box 20: Example of public communication for resilience in SUMP

The city of Klaipeda in Lithuania has a permanent Emergency Commission consisting of state politicians, senior civil servants and representatives of the military services. A so-called contingency manager[86] chairs the Emergency Commission and led an executive unit responsible for clear communication with all citizens and stakeholders during the COVID-19 crisis[87].

[86] It is someone in charge of planning for contingency and who create planned responses to events that might adversely impact the city and its systems

[87] POLIS & Rupprecht Consult. COVID-19 SUMP Practitioner Briefing

Resilience focus 11: Monitor and optimise measure implementation

Planners should monitor all measures throughout the implementation of a SUMP. The monitoring of measures along specific resilience indicators comes at the later stage. Proper monitoring of measures can reveal if things are going as planned, especially in times of crisis, and if certain adjustments are needed to optimize the overall results. Real-time monitoring can contribute to a bigger scale SUMP evaluation as it generates the necessary information, allowing risks to be detected early on and, to the extent possible, to be mitigated.

The involvement of citizens and the inclusion of their perception can also provide extremely valuable insights. For example, the level of citizens' trust in the use of public transport during the COVID-19 crisis has highlighted further steps (e.g. additional disinfection routines) to be considered in the recovery phase of public transport systems. By also referring to the existing risk and vulnerability assessments, it is possible to track the progress of a city's resilience-building process and to fine-tune the measures for maximum effectiveness.

Further monitoring-related thoughts to consider:

- Monitoring devices are indispensable to fully understand how the network is operating, including flows of traffic, blockages, passengers, asset conditions or wider events that could affect system performance[88]. Such information enables real-time changes based on the demand to optimise the system's capacity.

- Surveys allow transport managers and planners to understand how crises and emergency measures are affecting commuters and their mobility patterns. Data about specific social indicators provide transport operators with information on commuters' demands and needs.

- Wireless technologies and networks can deliver the speed and data flow capacity that is needed to base decisions on firm evidence. The use of wireless ticketing system enables system operators to remotely monitor traveller numbers across transport modes and prioritise responses in time of crisis.

Table 2 of the resilience focus 3 on page 25 highlighted the quick risk assessment, the resilience maturity model and the disaster resilience scorecard for cities as tools to be used ex-post for monitoring and evaluation. Table 7 provides additional tools for evaluation.

[88] Siemens, & Arup. Resilient Urban Mobility.

Table 7: Risk and vulnerability assessment tools for the monitoring of resilience in SUMP

Tool	Purpose	Type of tool	Method	Format
The City Resilience Dynamics Model (CRD)[89]	Helps cities explore different strategies regarding the implementation of resilience policies (including budgeting), simulate the results of each strategy and learn about the resilience-building process cities need to follow to improve their resilience level in the most efficient way	Multi-disciplinary tool that helps local governments choose their resilience policy implementation based on available budget and a 40 years simulation	The CRD encapsulates the most important aspects of the Maturity Model	Online tool
Cost-benefit assessment	Cost-benefit analysis of the resilience strategy implementation in comparison to the costs associated with non-intervention	Economic tool	A broad range of parameters can be incorporated into an overall assessment of costs and benefits (both understood broadly), such as: Monetizing crisis victims, increase in travel time, alternative service operations, other costs (energy consumption, etc.), direct cost and externalities. They need to be compared with the replacement costs of the concerned infrastructure.	Spreadsheet

Resilience focus 12: Build, evaluate and review from experience

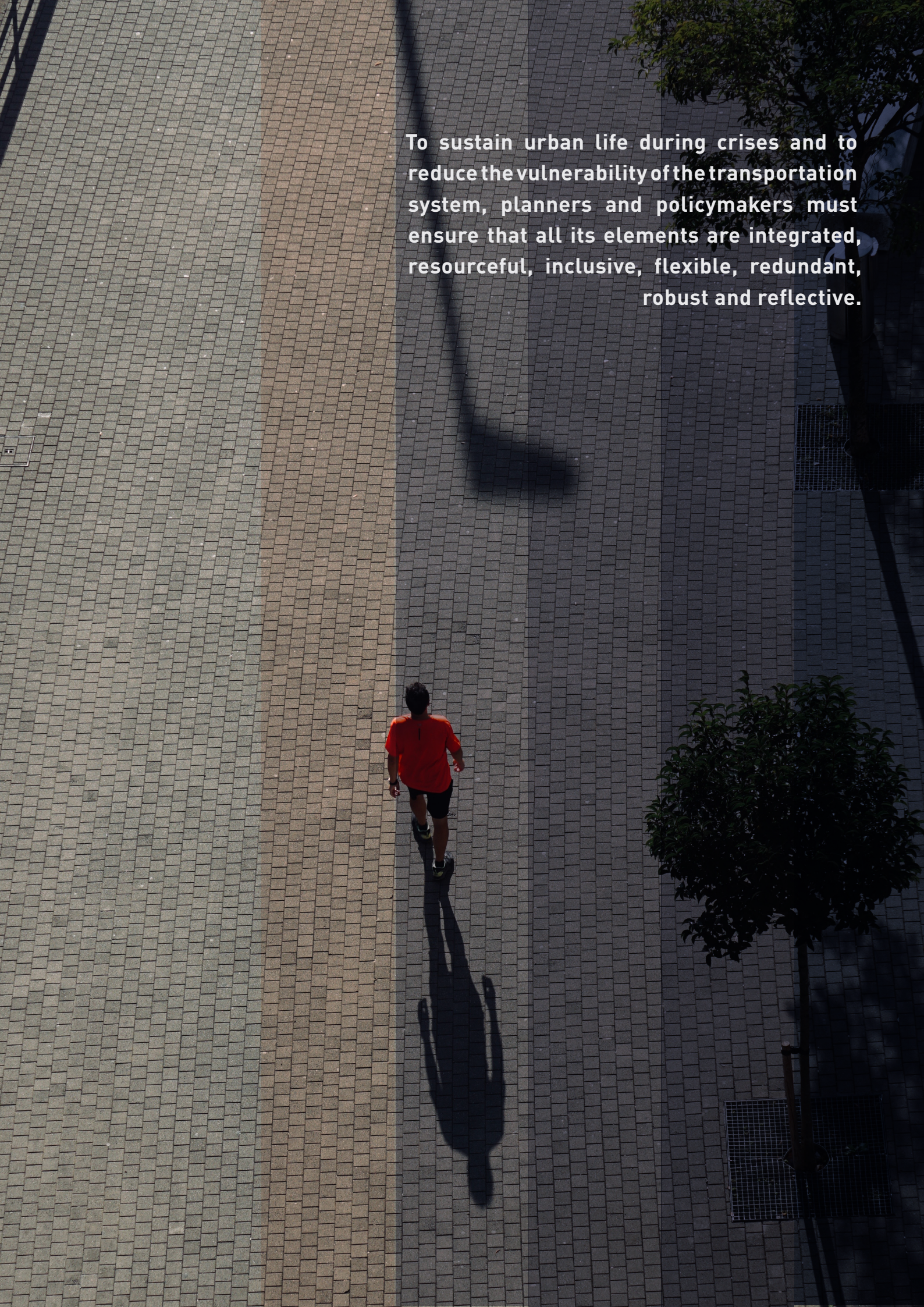
The COVID-19 pandemic has shown that well-documented and widely shared experience is key in building resilient transportation networks. Some cities quickly reacted and adapted their mobility plans by including the rapid implementation of new measures. When there was great attention to these fast popping-up measures and global media coverage, other cities could learn from the experience of how to face disturbances. Sharing experiences between different stakeholders contribute to a city's capacity to handle crises effectively, efficiently, with dignity and without compromising the pursuit of long-term goals while strengthening its mobility system's flexibility and robustness.

To share their experience in implementing resilience planning in their SUMP, municipalities should first consider evaluating the successes and failures through analysing the strengths and weaknesses of all phases and steps as well as the final outcomes. The previous step of monitoring, and more particularly in the case of resilience planning, the step of assessing short-term measures will have helped municipalities gather information during the implementation phase which renders this evaluation phase more straightforward.

To facilitate the exchange of such valuable experiences, it is recommended to make use of certain tools that are built for exactly this purpose, such as the Resilience Building Policies tool (RBP) and the Resilience Information Portal (RP). The RBP permits resilience teams to draft and upload detailed case studies and share the results of the evaluation with politicians, stakeholders, and citizens as well as other cities.

This point in the cycle marks the completion of the measure implementation and its evaluation, that is, the end of the whole cycle, and at the same time the start of a second iteration of the SUMP process. This represents a point of self-critical reflection and an opportunity to look back, to extract lessons learned and to feed them into future activities.

[89] Smart Mature Resilience Project. (n.d.). , City Resilience Dynamics, https://crd.smr-project.eu/index.html



To sustain urban life during crises and to reduce the vulnerability of the transportation system, planners and policymakers must ensure that all its elements are integrated, resourceful, inclusive, flexible, redundant, robust and reflective.

2. Section 2: Measure Fields

This topic guide covers nine measure fields that follow the taxonomy of the CIVITAS thematic areas: car-independent lifestyles (split into cycling and walking), collective passenger transport, electromobility, road safety, demand management strategies (split into UVARs and parking management), transport telematics, and urban freight logistics[90]. The measure fields cover the following topics:

- **Car-independent lifestyles**: measures that aim to get people out of cars and walking and cycling instead - the measures in this field cover topics such as modern information technology, safe and secure infrastructure, and public space reallocation for walking and cycling.

- **Collective passenger transport**: measures to maximise local public transport's potential by creating an accessible service that is a fast, reliable and convenient alternative to the private car.

- **Urban freight logistics**: measures to better coordinate and efficiently manage the delivery of goods.

- **Demand management strategies**: measures that aim to reduce traffic through a mixture of economic incentives, regulatory measures and modern communication technologies, split into:
  - UVARs: Urban Vehicle Access Regulations are measures that regulate vehicular access to urban areas.
  - Parking management: measures aimed at addressing congestion and traffic-related pollution in urban areas through actions linked to the control of parking provision.

- **Electromobility**: measures for introducing and pushing the use of clean vehicles and alternative fuels in cities' integrated (mobility) strategies.

- **Transport telematics**: measures to encourage the use of Intelligent Transport Systems (e.g. traffic control management, traffic optimisation, traffic monitoring) and digital tools to support new mobility services, e.g. Mobility as a Service (MaaS).

- **Road safety**: measures to improve the safety and security of different transport modes and road users.

The various measure areas above interact with and can mutually reinforce each other: balance in the overall transport supply can be maintained through shifts in the modal measure areas (cycling, walking, and collective passenger transport). For instance, cities can take action with regards to cycling, walking and shared mobility to compensate for the temporary unavailability of public transport.

The modal 'systems' (e.g. cycling, walking and collective passenger transport – measure fields that require entire systems encompassing physical and digital infrastructure - see table 8 below) rely on clean vehicles and Intelligent Transport Systems (ITS) to operate in a sustainable and smart way, while space used for parking can offer a buffer for urban space to be used for other modes, emergency centres etc.

Taking COVID-19 as a case study on how to deal with a crisis, each measure sheet includes a presentation of the topic and its relationship to resilience in urban mobility, an overview of the field during the COVID-19 crisis, and immediate actions and long-term considerations to increase resilience and preparedness for future crises. Some of the short-term measures can be applied to deal with other types of crisis. However, there is a clear emphasis placed on the current pandemic due to the research focus of the EU projects that have contributed to this document, and the necessity to provide cities and regions with guidance in this ongoing moment of need. This section provides a synthesis of the information. The reader is advised to visit the 'further reading' and references sections for more details and specific information.

How do the principles of resilience relate to the nine thematic fields?

Section 1.2 of this document "Principles of urban mobility resilience" presents the seven essential resilience principles that characterise resilient urban systems. To better understand how activities in the nine areas can impact the overall resilience of the city, partners working in research and innovation projects were asked: "how does your measure field contribute to each principle?".

[90] Thus broadening the scope compared to the COVID-19 practitioners' guide. This addressed three measures areas: cycling, walking and urban space reallocation; public transport; and shared mobility.

The results of this exercise are presented in the following table 8. The cycling, walking, collective passenger transport, UVAR and urban freight measure fields encompass entire systems (i.e. physical and digital infrastructure). Meanwhile, parking, electromobility and transport telematics refer to building blocks, enablers or components of these systems. Therefore, fields referring to entire systems contribute more to the principles than the component fields. Despite this, component fields remain highly relevant to increasing cities' resilience. As road safety is deemed a prerequisite of resilient systems, the authors decided that it should not be compared to the other fields during this exercise.

Table 8: Relation between Resilience Principles and measure fields

	Modal systems					Building blocks, Components		
Principles	**Cycling**	**Walking**	**Collective Public Transport**	**Urban Freight**	**Urban Vehicle Access Regulations**	**Parking Management**	**Electromobility***	**Transport Telematics**
Reflectiveness	4	4	4	4	4	3	2	4
Robustness	4	5	5	5	4	1	3	2
Redundancy	4	5	5	4	4	3	3	3
Flexibility	4	5	4	4	5	4	3	4
Resourcefulness	5	4	4	4	4	3	4	3
Inclusiveness	5	5	5	4	4	3	3	3
Integrated	5	5	5	4	5	4	3	4

1 - No contribution, 2 - To a low degree, 3 - To a medium degree, 4 - To a high degree, 5 - To a very high degree.

* Electromobility measures need to be combined with renewable energy sources and local energy production and use to contribute to city resilience.

Note: the table reflects the potential of the measure fields to contribute to the principles, but it does not imply that these principles are always achieved. Implementing measures in an ad hoc manner and without a long-term vision can have adverse effects on these resilience indicators. We invite the reader to make their own assessment based on the crises they plan to take into account and their local competences.

2.1 Car-independent lifestyles

2.1.1 Cycling

Cycling embodies resilience. An **inclusive** mode of transport accessible to all ages and backgrounds, it offers independence and it is **flexible** as it can be used for different journey purposes and to reach various destinations. It is now being embraced by people for a better quality of life and improved mobility.
Cycling has proved to be **robust** across crises and catastrophes, public transport strikes, war and unrest, fuel supply disruptions, traffic congestion and road network paralysis, and during the 2020 pandemic. It is **reflective** in the way that it has to respond and adapt to technological advancements, for instance e-bikes, without sacrificing the mode's universality. Indeed, e-bikes have boosted accessibility for certain user groups (particularly older people), while their use is normally free of licensing or training requirements.

Flexible and rapid to deploy
For safety and connectivity, infrastructure and/or the management of other vehicles is needed. The resourcefulness of stakeholders is often evident in cycling, and combined with strong political decision making, this means space can be found very quickly and affordably for cycling infrastructure. In itself, increased ridership creates support and improves attitudes.
Cycling is a very flexible transport mode used in different climates and topographies, while possible to use in rural and urban areas and in shared space or in separate infrastructure. Cycling also requires less space than motorised private transport. This **flexibility** puts the resilience category of **'redundancy'** in a specific light:

space used for cycling can be easily converted into social/walking space in times when cycling is not the mode of preference. In other conditions, cyclists can take over the space (and modal share) of other modes if this becomes redundant due to lack of use.
Cycling provides **integrated** last-mile access to other forms of transport which may be reduced during crises, and can be expanded to deliver goods and supplies (e.g. see CityChargerCargoBike[91]).

Proven and robust
A wealth of knowledge is available on how to design cycling infrastructure, which itself relies on simple materials and proven construction techniques with low levels of wear and tear. This is coupled with the bicycle's resilience as a vehicle, in itself a **robust** concept with extensive value and "circularity" potential in its purchase, repair, resale and reuse. These processes also support a significant employment ecosystem.

Healthy
Cycling improves physical and mental health, and as a zero-emission transport mode it helps create clean and quiet local environments. The ability to travel speedily and unconfined outside has also allowed people to exercise and commute safely with almost no exposure to the virus. In addition, cycle lanes do not necessarily block emergency vehicle access. With good road design based on flexible street space, they can transport patients more quickly than on most conventional roads where cars must make space.

Underexploited
Having said that, the resilience of cycling is threatened by a lack of safe conditions, with cyclists often competing for space with other transport modes. In addition, it is not always highly prioritised by politicians, investors or decision makers. Slow growth in levels of cycling is often coupled with underinvestment and low standards of design, implementation and management compared to those required for cycling to be a mode of transport accessible to all users all year round (cities like the Finnish capital Helsinki and the Belgian city of Bruges involved in projects such as CIVITAS Handshake are working to make this possible[92]).

[91] CityChargerCargoBike Information page, 2021 http://cyclelogistics.eu/

[92] CIVITAS Handshake portal, https://handshakecycling.eu/

Dealing with COVID-19

The introduction of lockdowns in most EU cities has meant fewer people in the streets and less motorised traffic. At the same time, local authorities have recognised that safe distancing and quick movement of people can be achieved by promoting cycling and walking. To promote cycling, many local authorities introduced pop-up cycling lanes as emergency measures. This led to an increase in bike use; increased sales of bicycles; most cycling stores selling out their stock; and long supply chains being put under strain like never before.[93]

Short term measures

Cycling has been permitted almost universally and continuously throughout the pandemic. Even where public transport has been closed down or greatly restricted, cycling has usually been positively encouraged to keep people exercising and well-being high during the sedentary periods that come with confinement. However, it has been necessary to devise imaginative solutions and overcome challenges to cater for this.

Planning, regulations and standards: Some cities have put in place lower speed limits (e.g. 20 km/h). There has also been a need to embrace experimental design tried and tested in pilots but never before adopted on a broad scale. Many approaches were based on tactical urbanism, such as painting bike lane markings on roads, introducing parklets, opening streets for non-motorised modes, and bringing in 'light' segregation for cyclists with temporary plastic wands/kerbs.

Infrastructure: In some cities, it has not been felt possible to implement physical street space measures rapidly due to commitments to consultation. Measures such as prioritising cycling traffic in signalling at traffic lights can be a less controversial but effective way of accommodating cyclists in greater numbers more comfortably (taking into account social distancing).
The width of streets or paths has also limited cycling at times, with those prioritising movements on foot. For example, a narrow shared path in Bruges was closed to cyclists in order to maintain social distancing for pedestrians. The use of existing mixed streets (unseparated by fixed boundaries/kerbs) has served as a robust model for providing people enough space to walk and cycle while still socially distancing. Other ways to create additional circulation space during a crisis are to convert two-way infrastructure into one-way systems, to allow cycling in prohibited areas, and to extend the time that areas are made free of motorised traffic.
Modelling and assessment: Changing patterns of cycling have been observed during the crisis. The reduced amount of trips to work combined with increasing leisure needs have created a different balance of priorities and movements, whilst at the same time demonstrating cycling's flexibility and its lack of redundancy. Some cities have put in place specific monitoring for pop-up routes, while others have used existing permanent counters. Their use of this knowledge and data has contributed to increased reflectiveness in these cities.

Awareness raising in a crisis: In times of crisis, public messaging operates on multiple levels and needs to be coherent and understandable.

[93] The Conversation, 'How Coronavirus made 2020 the year of the electric bike', 2020, https://theconversation.com/how-coronavirus-made-2020-the-year-of-the-electric-bike-143158

Box 21: Cycling best practice examples from the UK and the city of Budapest (Hungary)

In Budapest (Hungary) the COVID-19 restrictions made apparent the need for alternative solutions that allowed citizens to move around safely and without relying on individual motorised vehicles. Restrictive measures such us lockdowns and curfews decreased car traffic, giving local authorities the needed space to develop and encourage non-motorised modes. The city set up temporary bike lanes during the spring of 2020 on main roads that were previously heavily affected by car traffic. The aim was to encourage cycling as a good alternative to the car and public transport while preventing car traffic to grow back rapidly, exceeding even previous volumes. Several sections of bike lanes were implemented in the downtown area in a total length of 12 kilometres, mainly on former car lanes. After restrictions were lifted, some interventions were heavily disputed - despite obvious health and road safety reasons – which led local authorities to compromise and back off some of the new implementations. This episode highlights the importance of preparing consultation and awareness raising processes to implement controversial measures, even in times of crisis.

In the UK, advice at the national level has shown a consistent commitment to the role of cycling as a means of healthy (and COVID-19 safe) exercise, reinforcing local initiatives. The wording of schemes has often encouraged inclusivity, relating cycling to the use of public space and quality of life. Here are examples of ones to have done so:

- Manchester's Safe Streets Save Lives campaign; emergency active travel schemes
- Open Streets London and Living Streets London
- Rome's transitory cycle lanes in the context of its "Isole Ambientali" programme
- Cadiz's "Have you tried" COVID-19 awareness and cycling information campaign

Long term measures: aiming for Resilience

When a crisis occurs, there are never enough resources, knowledge and protocols to respond in the ideal way. However, being prepared and examining possible scenarios that might affect a transport system can save lives and resources when responding. Cycling can be particularly resourceful through its grassroots support and local stakeholders. Potential activities include, but are not limited to:

Preparing stakeholders for resilience

- Prepare an emergency contact database of stakeholders (e.g. service delivery companies, shop owners, and a wide-ranging citizens' panel).
- Use transition management processes such as those tested in CIVITAS Handshake to envisage future scenarios.
- Devise a "quick" public participation model to fast track consultation processes.

Building skills

- Train transport practitioners in short-term design solutions.
- Use available tools to have local authorities determine their strengths and weaknesses in advance.

Preparing designs and operational processes

- Seek approval for emergency design responses and investigate supply chains and procurement processes.
- Consider spacing and sanitary requirements and messaging needed.

Document emergency plans

- Review the cycling network plan, paying particularly attention to bottlenecks and width restrictions on key routes that could be opened up to aid future resilience.
- Adopt an emergency transport hierarchy to reconcile different ways of seeing and using a neighbourhood in times of crisis.
- Prepare a decision process to review and move from immediate short-term measures to longer term measures which contribute to creating high quality urban space.
- Consider the importance of access to key destinations, such as green space.
- Capture the above in "emergency plan" for cycling in the event of crisis.
- Look to integrate these improvements in the medium and long term into action plans and SUMPs.

Be prepared to help users

- Prepare journey planning systems (e.g. MaaS) applications to support people in making journeys they are not used to or familiar with.

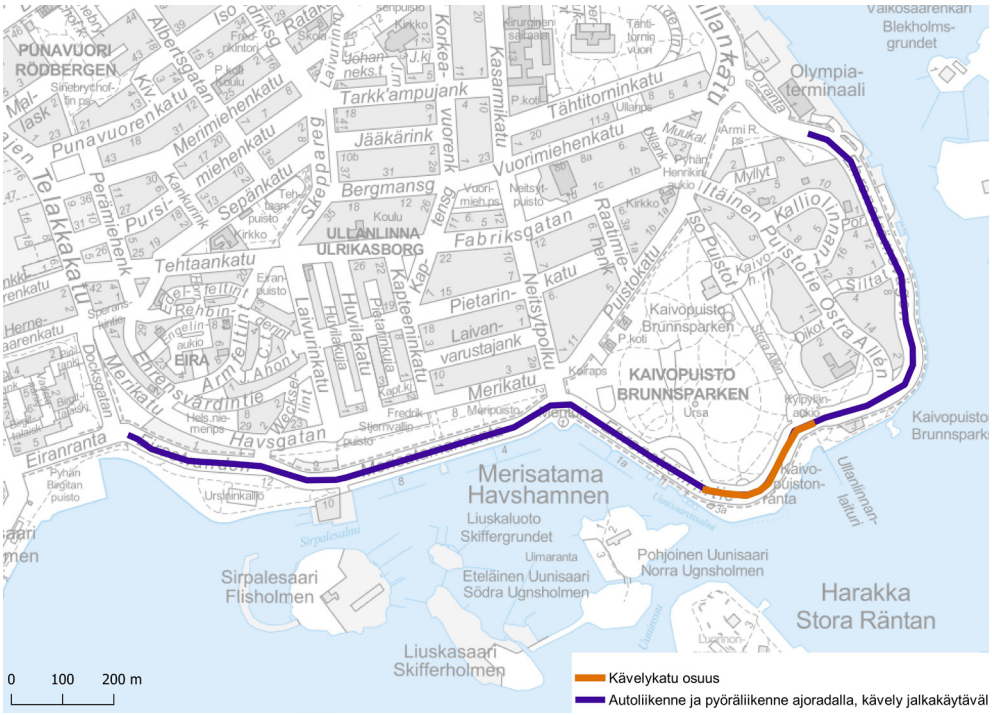
Collecting data

- Report evidence from on-site tracking and users' perception over the course of the crisis (documenting support for cycle- and people-friendly public spaces).
- Emphasise the long-term role of cycling in city transformation and its requirement for sufficient space alongside other modes and street uses.

Repurposing streets for cycling and leisure in Helsinki, Finland

CIVITAS Handshake

Following the first wave of the COVID-19 pandemic, life was returning to, what has been termed a 'new normal' during the summer months. Yet, home working and reduced traveling abroad for summer holidays was advised, and citizens were advised to stay as much as possible in their local area. Summer weather in Helsinki, Finland, enticed its residents onto the streets. Based on the citizens' initiative started on social media, Mr. Jan Vapaavuori, the Mayor of Helsinki, closed one of the streets in the city to cars. One km of the "beach route" of Ehrenströmintie street, was repurposed with traffic calming measures, with 300 meters of this designated for only walking and cycling. Moreover, 40 car parking spots were repurposed within this area that provided the residents with a liveable space with on street features, such as benches, paintings and flowers.



Orange:pedestrian zone / Blue: traffic calming zone

Figure 4. Repurposed route in Helsinki.
Source: City of Helsinki

The testing period for this solution ran from June 22nd until August 31st, 2020.

The city of Helsinki surveyed the aforementioned part of the street prior to and after closure, and as expected, the number of walkers and cyclists recorded increased significantly. Furthermore, the feedback on the measure was collected from both residents and local business owners on that particular part of the road, and will be deployed in future planning of similar measures.

Crisis as a catalyst for active transport reform in Bordeaux, France

CIVITAS Handshake

Whilst the COVID-19 crisis stopped or postponed many projects planned in Bordeaux (France) several projects previously planned for by the city authorities were accelerated. Due to rising demand for cyclable and walkable public space, the city of Bordeaux implemented the provisional cycling measures, the so-called "Cycling Emergency Plan" to combat COVID-19, with the possibility of becoming a permanent solution.

The set of cycling measures adopted a dual approach: infrastructure build up and improvement, and service consolidation. Infrastructure included temporary facilities, 80 km of bike lanes, enlargement of existing bike lanes, bike parking, air pumps and other physical solutions to support and improve cycling. City authorities also created and disseminated a map for the citizens on where to locate the additional bike lanes. Services, on the other hand, included a number of bicycle repair shops, bike purchasing incentives, and bike loan for student schemes, started in September 2020.

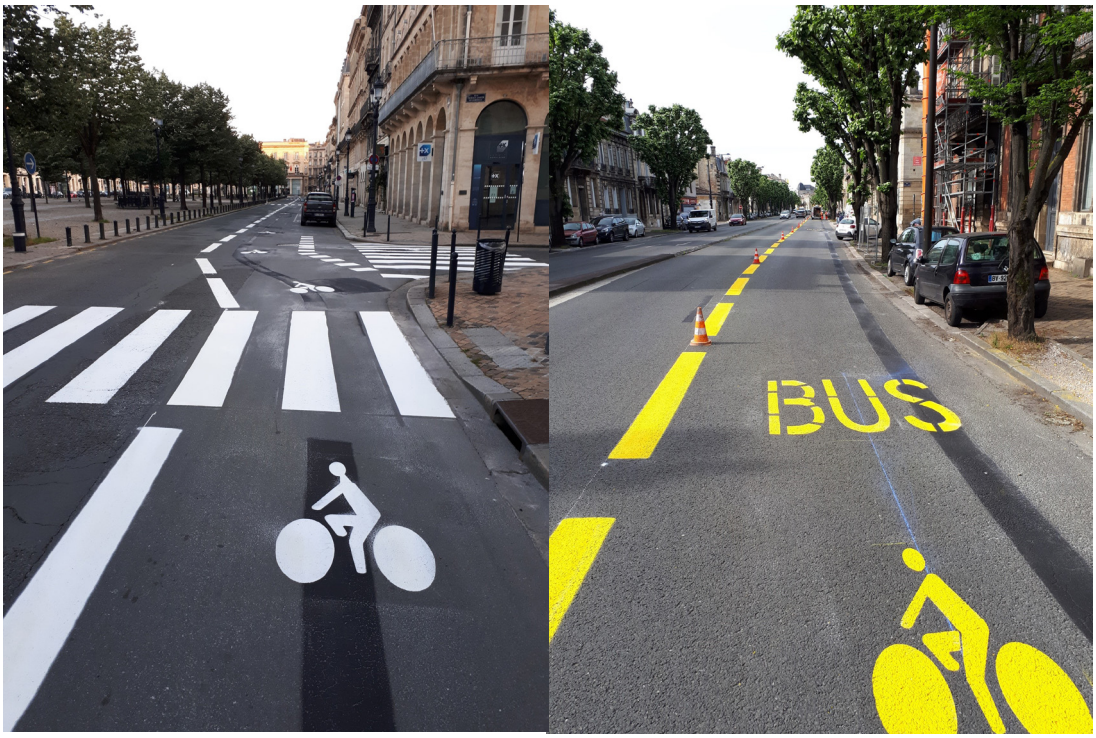


Figure 5. Right: boulevards de Bordeaux, creation of bus/cycling lane, Left: allées de Tourny, Bordeaux, enlargement of existing cycling lanes.
Source: Bordeaux metropole

Pop-up bike lanes to allow physical distancing in the city of Belo Horizonte (Brazil), and Quito (Ecuador)

SOLUTIONS+

Cities' departments in Latin America, such as Belo Horizonte and Quito, have been implementing various measures in the context of the COVID-19 crisis, such as the deployment of temporary bike lanes throughout the cities to provide free and safe daily transportation ensuring social distancing, physical activity, and improving air quality.

In Belo Horizonte, the intervention adds approximately 30km of bike lanes to the existing 90km. Amid the pandemic, the transport department formed a working group to explore possible solutions for sustainable mobility measures to deal with COVID-19. After a virtual meeting with stakeholders, a ride with 30 cyclists was organized to assess the optimum solutions for implementing temporary bike lanes in 5 sites.
On the other hand, the city of Quito reviewed multiple case studies around the world and collaborated with other municipalities such as Berlin, to develop a plan to create new bike lanes with clear objectives.

Both cities used a participatory implementation process involving the community in the development of plans as well as the cities' management team to support actual implementation. As a result, the municipalities created more practical and secure cycling lanes, inserting lanes on the left side of roads to minimise disturbance of public transport and creating one-way streets. Some of these temporary bike lanes were also connected to the local BRT systems. The municipalities also implemented physical barriers to separate cyclists from traffic flows as well as new signs to guide both drivers and cyclists.

The temporary bike lanes were received by Belo Horizonte's citizens, so much so, that the city decided to double the number of new lanes along with adding new pedestrian paths. In May, Quito saw a 734% rise in bike trips and sought to maintain this trend. Overall, the emergency measures were thought to increase cyclists' security and improve access to different major areas of the city, such as metro and bus stations, malls and hospitals.

Figure 6. Creation of temporary bike lanes in the city of Belo Horizonte, Brazil.
Source: Belo Horizonte Transport Authority

Figure 7. Pop-up lanes in Quito, Ecuador.
Source: Twitter of Quito's Secretariat of Territory, Habitat and Housing

2.1.2 Walking

Walking is an essential part of all journeys: every journey begins and ends with a walk, including trips made by public transport. Thus, enabling safe walking is fundamental to achieving **integrated** mobility systems. Together, walking and cycling provide well-known economic, social, urban, ecological and health benefits, as mentioned in the previous chapter. Walking is a simple and cost-effective way of achieving the recommended physical activity levels for personal health and well-being and can reduce noise and improve air quality.[94] It also makes mobility systems **inclusive**, and has the potential to reduce inequalities as it is accessible, affordable, and socially equitable.

Yet vulnerable road users have largely been ignored in the planning, design, and operation of cities. Indeed, the contribution walking makes has been historically undervalued due to car-centric urban planning, which has resulted in a lack of appropriate urban infrastructure for safe walking. The undervaluing of walking is especially relevant (although does not exclusively apply) in low- and middle-income countries, where many people (especially the most vulnerable) cannot choose another mode of transport. Their lives are put at risk due to poor or non-existent infrastructure. Urban space must be designed in a manner that is accessible, safe and attractive for pedestrians in order to reduce dependence on motorised transport and achieve **robust** transport systems.

Making it easier to walk and cycle – both for getting from A to B and leisure - whilst improving public transport reduces traffic congestion and enhances urban air quality. It also helps create more **flexible** and **redundant** transport systems that can cope with disruption better. Cities suitable for walking are also compact, dense, diverse and developed for mixed uses. Cities like Paris (France) have realised this and are now working towards strategies such as the 15-minute city in which walking plays a central role (read more in box 22).

Walking is integral to society's recovery from COVID-19 and to creating resilient cities that are less car-dependant. People need safe, enabling environments in which to walk and cycle – not just for recreational reasons, but also for everyday journeys. Increasing walkability makes cities more sustainable, healthy, liveable and **resilient** to future (potential) shocks.

The COVID-19 pandemic has further highlighted this. Yet infrastructure needs to be improved in order to make walking a safe and convenient option.

Dealing with COVID-19

During the lockdown, cities all over the world have been reallocating space from cars to pedestrians, transforming parking spaces and car lanes to expand pavements and improve public space. Many of these measures were implemented as temporary or emergency measures. These allowed for testing and trialling so that cities could explore what the best solutions might be. The pandemic helped reveal that urban space is not fairly distributed, as private motorised vehicles take up too much space. Cities need to provide enough space for people to walk in safe conditions and maintain physical distancing.

This experience has demonstrated that local authorities can be responsive and agile in times of need, and that respacing streets to promote active travel does not always require large amounts of money, complex design, nor time-consuming administrative processes. In many cities with large-scale implementation, it appears that political support, partnerships between transportation organisations and public health officials, and community input spurred innovation.

In low- and middle-income countries where walking is the most accessible mode of transport and represents the majority of journeys, the need for safe walking environments is huge. However, there appears to be less coordinated action in such places. The International Road Assessment Programme suggests that most walking in low- and middle-income countries happens where there is no infrastructure to support basic safety needs. They estimate that 70% of roads have no pavements and 89% no pedestrian crossings. This pre-existing safety crisis causes the highest levels of road casualties in the world.[95]

[94] WHO, A European framework to promote physical activity for health, 2019, https://www.euro.who.int/__data/assets/pdf_file/0020/101684/E90191.pdf

[95] iRAP, Case study: 5-Star Cities for all road users, 2019 https://www.irap.org/2019/04/new-case-study-available-5-star-cities-for-all-road-users/

Short term measures

Space reallocation measures to promote walking have fulfilled two main purposes:

- giving room to move: repurposing parking spaces and road space to support physical distancing and travel connections.
- giving room to queue: widening pavements for queuing by repurposing curb-side lanes, providing space for people to line up while giving pedestrians room to pass by. Priority is given to waiting areas associated with essential activities (food shops, health infrastructure, pharmacies and public transport stations).

Speed reduction measures/ slow streets:Many cities are reducing speed limits during lockdown to ensure safe walking and cycling for a large number of users. This has been particularly prevalent on residential streets. Lower vehicle speeds enable safer, healthier and more liveable environments. On 1 January 2021, Brussels introduced a city-wide 30 km/h limit[96]: this applies equally to all vehicles and aims to create safer roads, a better quality of life, and a calmer city for everyone. Other cities implementing city-wide 30 km/h limits include Graz (Austria); Grenoble (France); Helsinki (Finland); Valencia (Spain); and Zurich (Switzerland).

Spatial design interventions: Several cities have been reallocating space from cars to create more enjoyable, attractive spaces. Strategies for this include the creation of parklets, the installation of climate adaptation elements (e.g. creating more shade), and the installation of urban art. The Planning for Walking Toolkit[97] developed by Transport for London (2020) provides advice for planners and designers involved in the redesign or creation of the public realm in order to contribute towards creating a more walkable city.[98]

Open streets: Such streets are entire streets that are open to cyclists and pedestrians and closed to all but emergency/essential car access. Open streets can be used as play streets, school streets or markets.[99] Examples of open streets have been implemented in Berlin (Germany); Brasilia (Brazil); and New York (USA)[100]. Respacing can also support teleworking by creating physical environments in urban areas where children can safely play on the street. Pleasant, sufficient and green outdoor spaces are also extremely important for physical and mental wellbeing.

Box 22: An example on walking best practices from the city of Paris

Since her election in 2014, Mayor Anne Hidalgo has changed the mobility culture in **Paris**. She has banned the most polluting types of vehicles in the city centre and transformed busy roads flanking the Seine into a linear park. In 2020, she announced her plans to make the French capital a "15-minute" city. This concept seeks to design cities in which residents can reach everything they need by foot or bike within 15 minutes and each neighbourhood fulfils six primary social functions: living, working, supplying, caring, learning and enjoying.

This will entail remodelling cities in order to have mixed-use neighbourhoods with homes, offices, health centres, bars, schools and recreational spaces. More road space will be used for pedestrians and cyclists, and open spaces will have multiples uses at different moments of the day. For example, what is a school playground during the day can become a sports facility at night. This kind of transformations involve collaboration between the different local authority departments responsible for education, sport, roads, and parks, as well as local business and community organisations.

Some recommendations for the short-term:

- Use technical specifications: Quickly deployed infrastructure is not necessarily synonymous with low-quality infrastructure. Technical guidance is available that provides a good foundation for planning safe, temporary infrastructure that can be implemented almost immediately in towns and cities. Safety of pedestrians and cyclists at intersections needs particular attention[101].

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[96] Brussels City 30, Information Page, 2021 https://city30.brussels/

[97] Transport for London, Planning for walking Toolkit, 2020 http://content.tfl.gov.uk/the-planning-for-walking-toolkit.pdf

[98] The Planning for Walking Toolkit does not create a new design policy, but instead references existing design approaches and policy to emphasize the importance of high quality places for walking.

[99] NACTO, Streets for pandemic response and recovery, 2020 https://nacto.org/publication/streets-for-pandemic-response-recovery/emerging-street-strategies/open-play-streets/

[100] NACTO. Streets for pandemic response and recovery.

[101] NACTO, Don't give up at the Intersection, Designing all ages and abilities bicycle crossings, 2019 https://nacto.org/wp-content/uploads/2019/05/NACTO_Dont-Give-Up-at-the-Intersection.pdf

- Ensure accessibility and safety: Goals such as ensuring access for people with disabilities and road safety must not be overlooked in the rush to implement infrastructure measures.

- Support local businesses: Space reallocation measures can also be used to reactivate local businesses, as claimed by recent research from Transport for London (TfL) and University Colleague London (UCL)[102].

- Enable deliveries: Space reallocation measures should be done considering the needs of the urban logistics sector. It is important to identify how to best accommodate deliveries and drop- offs on streets where loading bays and on-street parking have been removed.
- Go beyond city centres: The improvements to street space should not be limited to city centres, but should also include peripheral neighbourhoods to help people move more easily and safely in the areas they live in.

- Tackle speeding: Police in different cities have reported a rise in speeding on quieter roads as a result of coronavirus-related travel restrictions. In the midterm, the fight against speeding must remain a priority.

Long term measures: aiming for Resilience

In order for cities to become resilient, walking needs to be further promoted, making it possible for citizens to conduct their everyday activities on foot.

Recommendations for long-term resilience in the framework of this policy field are:

- Communicate benefits and raise awareness: Conveying the multiple benefits of walking to a wider audience will make change easier.

- Collect feedback: Citizens need to be encouraged to share any concerns they have and what interventions they believe are required.

- Enforce and educate: In order to prevent new walking infrastructure from being misused, enforcement and education are key. Whilst the cost of temporary infrastructure is relatively low, enforcement costs are not to be ignored, and they require coordination with other budgets such as those of the police. The fight against speeding must also remain a priority.

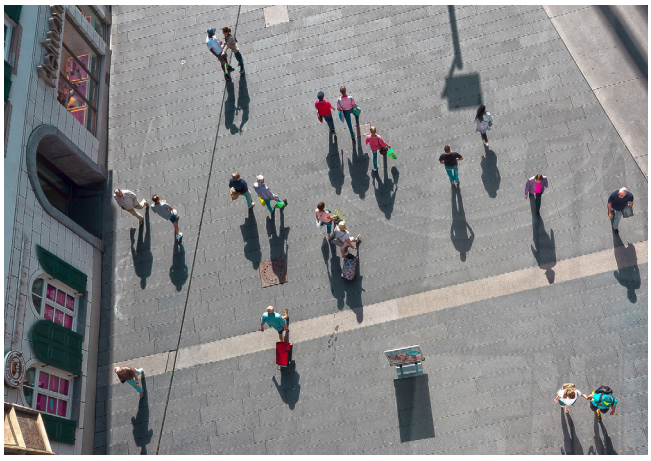
- Foster political support and leadership: In many of the cities which have quickly implemented reallocation measures, a mayor or council member has often been included in or at the forefront of the decision (as well as its media portrayal). As leveraging political support is crucial to achieving changes 'on the street', prioritise engaging with the government and seeking to spur government action.

- Foster partnerships and collaboration with public health officials, departments and NGOs: Such strategic partnerships offer valuable perspectives, evidence-driven evaluation, and buy-in for future transitions to permanence.

- Create further guidance: In addition to existing guidance, more guidance on street design during pandemics needs to be published.

- Improve proximity to services (towards the 15-minute city): There is a strong link between the potential for active travel and urban layout: complex, dense and compact urban fabrics are more suitable for walking and cycling. Cities that have everything that a person needs for living within a 15-minute walk or cycle have huge potential to become sustainable and resilient.

- Transitioning to permanence: When feasible, temporary measures that reallocate space to promote walking must be made permanent. There is a need to build now what we wish to have in the future: more sustainable and resilient mobility ecosystems.



[102] Transport for London, The value of street improvements Summary Report, http://content.tfl.gov.uk/street-appeal.pdf

Active travel transformed by Dublin's (Ireland) COVID-19 response

CIVITAS ELEVATE

A key challenge for Dublin in responding to COVID-19 was creating more space on its city's streets to enable social distancing and to encourage more active travel, thus reducing pressure on public transport.

As part of its COVID-19 Mobility Programme (CMP), Dublin City Council ran a trial which pedestrianised several city centre streets for six weekends during the summer. This allowed cafes and restaurants to construct outdoor seating, enabling customers to meet and remain socially distanced. Both customer and business feedback were overwhelmingly positive. 96% of survey respondents reported that pedestrianisation improved their on-street experience, and a large majority supported permanent pedestrianisation. This is now being proposed for some of the streets involved in the trial.

The city is aiming to triple cycling numbers, thus creating protected, safe and continuous cycling routes, accessible for all is vital. This is the central aim of the Griffith Avenue Cycle Lane. Currently under construction, it will provide a 2m wide, high-quality, protected cycle lane on both sides of a 3.5km main road. This route has been prioritised under the CMP due to the number of schools and colleges in the area. Through the provision of safe cycling routes to schools and colleges, the city hopes to cultivate a cycling culture among the next generation.

By making active travel more attractive and safe, the Irish capital is creating a well-rounded, resilient and sustainable mobility system.

Figure 8. Pedestrian trials in Dublin
Source: Dublin City Council

Rotterdam's (Netherlands) Walking Strategy: Walks 25 the pedestrian on a pedestal

The City of Rotterdam has launched Rotterdam Loopt 2025 (Rotterdam Walks 2025), the city's first dedicated policy to improve walkability for people in Rotterdam. It sets out an 'Ambition and Call to Action' that puts 'The Pedestrian on a Pedestal', following an integrated approach to capitalize on the health benefits of walking.

The strategy aims to make important destinations like public transport hubs, parks and schools, more attractive and accessible, ensuring that the citizens of Rotterdam can walk longer distances, more often, and under better conditions.

What can others learn from this example? The City consulted locals and visitors about where they enjoyed or disliked walking. Citizens have a good understanding of where it is pleasant to walk, and where improvement is needed, so it is instrumental to involve them in identifying and implementing measures. For this purpose, the city launched the 'Will you walk with me?' campaign, mapping the places where people enjoy walking the most and the areas that are less popular, as well as the reasons behind this. The most frequent ideas for improvements were related to: prioritizing pedestrians over cars, better wayfinding, improving cohesion at route level, more greenery and better maintenance of pedestrian infrastructure.

To turn these ideas into physical improvements, the City of Rotterdam is currently working on an action plan in collaboration with the affected neighbourhoods and their inhabitants.

Figure 9. Rotterdam's 'Will you walk with me?' Campaign.
Where are pleasant and less pleasant places to walk in Rotterdam? (North Bank)

2.2 Collective Passenger Transport

During the COVID-19 crisis, public transport providers have faced the dual misfortune of collapsing demand combined with increased operating costs. In the future, profitability will continue to be affected by reduced patronage, this diminishing both ticketing revenues and ancillary revenues from advertising, retail, and property development. As well as seeking essential short-term cost reductions and improvements to staff and asset productivity, public transport providers now need to consider more pivotal and fundamental adaptations that can be made to their service offers and operating models.

Public transport operators should adapt their offers to improve resilience in case of rapid fluctuations in future demand due to crises. This can be achieved through the use of predictive data analytics to improve **robustness** and timeliness of information; the adaptation of capital investment approaches to improve **redundancy** within current infrastructure; new agile and flexible crisis management processes; increased **flexibility** of staff schedules and tasks; partnering with relevant third parties to increase **resourcefulness**; and partnering and **integrating** new mobility services to achieve **inclusiveness** across geographical areas served.

Dealing with COVID-19

The crisis caused by COVID-19 has had a major impact on public transport systems across the world. Some lessons learnt from the crisis are the following:

- **Public transport is essential**: The COVID-19 crisis has highlighted how essential public transport is to guarantee access to and continuity of basic services in times of crisis. During the lockdown, public transport supply was maintained all over the world to ensure the mobility of essential frontline workers.

- **Public transport is vulnerable**: Since the outbreak of COVID-19 pandemic, the local passenger transport sector has been hit hard. The main problems were a dramatic decrease in ticket revenues and the difficulty to provide good quality regular services while keeping both staff and users safe. Nevertheless, most public transport companies – whether public or private – maintained a high service level (between 70 and 100% of the normal offer) and implemented safe distancing measures; the latter meant more vehicles were needed to transport all passengers. There were also substantial expenses and effort involved in cleaning/disinfecting vehicles and providing masks to staff.

- **Public transport is safe**: Despite the lack of scientific evidence, many governments have called for people to avoid using public transport and instead to travel by car or to cycle or walk. With the media also quick to relay such ideas, this messaging has impacted people's behaviour and their perception of feeling at risk in public spaces, including public transport. Today, there is enough evidence to demonstrate that, when measures recommended by health authorities are implemented, the risk of catching COVID-19 in public transport is very low. If people recognise that zero risk does not exist, then public transport remains one of the safest ways to move around the city. Scientific studies and empirical analysis evidencing this include one from the Robert Koch-Institut (Germany). Recent data from the RKI (2020) showed that 0.2% of traceable outbreaks in Germany were linked to transport and involved fewer people per outbreak than those in frequently affected settings[103]. In addition, data collected during the summer of 2020 by the Santé Publique France (the French Public Institute on Health Information) revealed that only 1.2% of COVID-19 clusters are linked to transport (land, air and sea).[104]

[103] Robert Koch-Institut, Epidemiological Bulletin 38/2020, August 2020 https://www.rki.de/DE/Content/Infekt/EpidBull/Archiv/2020/Ausgaben/38_20.html

[104] UITP, Public Transport is COVID-19 safe – Policy report, 2020, https://cms.uitp.org/wp/wp-content/uploads/2020/10/Policy-Brief-PTisCOVID-Safe.pdf

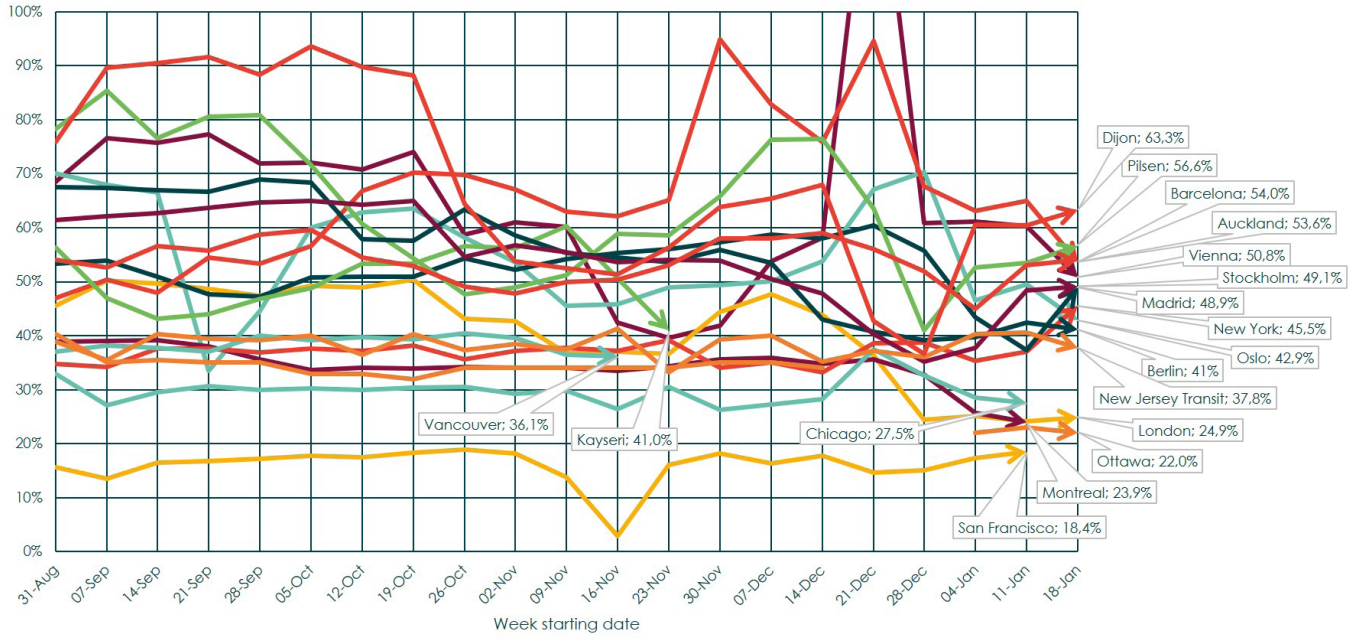


Figure 10. Multimodal operators - weekly evolution since the start of September 2020 (UITP public transport ridership evolution, 2021)

Short term measures

During the pandemic, a number of measures have been implemented to protect public transport workers' and passengers' health and avoid spreading the virus. They include:

- Ensuring that all workers and passengers receive the latest and most accurate information about COVID-19, including ways to limit and avoid transmission.
- Providing staff in all occupational groups with adequate personal protective equipment (PPE), including gloves, masks, hand sanitising products and other appropriate materials.
- Regular deep cleaning and disinfection of public transport vehicles, workplaces, stations and things that users come into contact with, including ticketing devices, poles and seats.
- Limiting the interactions of drivers and other public transport workers with passengers - for example through having no cash ticket sales on-board, allowing rear-door boarding only, covering the driver's area with a plastic sheet, cancelling in-person ticket inspections etc. -, as well as ensuring physical interaction between colleagues within public transport companies adheres to safe distancing standards.
- Making disinfectant dispensers accessible for workers and passengers.
- Maintaining high levels of service despite the reduction of travel demand to ensure safe distancing whilst keeping service continuity.
- Adapting services and timetables to comply with decisions taken by public authorities and communicating these alterations clearly. Changes might include night services and school services being suspended in some cities, networks following weekend or school holiday timetables as agreed with trade unions, and offering new on-demand services.
- Providing dedicated services to healthcare personnel, patients and any other category of the workforce deemed as performing an essential service.
- Communicating on measures being implemented to ensure safety, thereby reassuring workers and passengers.

Long term measures: aiming for Resilience

To make public transport resilient in the long-term, solid public funding must be in place and digital platforms used to adapt transport services quickly in line with shifting demand patterns, increasing the **flexibility** of the system. All transport modes need to be **integrated** into planning: from track-bound vehicles and buses to sharing options that can easily step in to fill supply gaps. Planning for enhanced connectivity and the digitalisation of all mobility options lays the foundations for the long-term development of resilient transport systems.

Cities across the world have understood that, with this crisis, now is the time to move forward on sustainable urban mobility. Indeed, many have already begun to remodel their urban space and review the amount of road space disproportionately allocated to private cars in previous decades. Public transport can benefit from this reallocation by increasing the amount of road infrastructure dedicated to segregated priority lanes for public transport. This would enhance both the reliability and overall quality of services. Public transport is and must continue to be the backbone of mobility in cities. For this to remain the case, the complementarity and **integration** of active, shared and collective modes of transport is key.

The digital revolution has brought radical changes to economies, including freight and passenger mobility, and has encouraged new actors to enter the mobility market. While new mobility services can affect city mobility management and impact the urban streetscape, they can also augment existing mobility options and facilitate car-free lifestyles if made part of wider city strategies. Cooperation, partnerships and dialogue are crucial to create a redefined public transport system that integrates these new complementary services with public transport in an efficient and sustainable way.

Health is not only an indicator for monitoring progress, but also an essential element to ensure sustainable development. Placing health and well-being at the centre of the planning process can foster good livelihoods, build resilient and vibrant communities, give voice to vulnerable groups to become more **inclusive**, and drive efforts to reduce inequalities in urban areas. Cities and regions must ensure that public transport can continue to contribute to the goals set in local or regional SUMPs without compromising on health and safety requirements.

Urban mobility plays a vital role in helping cities prosper, but this can only truly apply if stakeholders step up their collaboration to support public transport. Institutional frameworks and market regulations differ in line with local specificities, but the starting point of any city's strategic development plan should be to craft a common vision in which urban mobility delivers on the city's strategic objectives and generates wider socio-economic benefits. Twinning long-term strategies with tactical measures fosters consistency in the decision-making process, freeing it from the instability caused by political cycles. Current short-term initiatives enabling walking and cycling should evolve into long-term solutions whose development involves public transport stakeholders.

The impact of COVID-19 on Sustainable Urban Mobility for Athens (Greece)

HARMONY

The COVID-19 pandemic has had severe socio-economic consequences in Greece, and especially in its capital Athens, home to almost half the country's population. Government measures against the spread of COVID-19 in the Athens area had also a strong impact on the transport sector. Figure 6 presents the impact of COVID-19 on the Public Transport (PT) ridership and how demand (ticket validations) for PT has dropped by 40%-90% since the beginning of the pandemic.

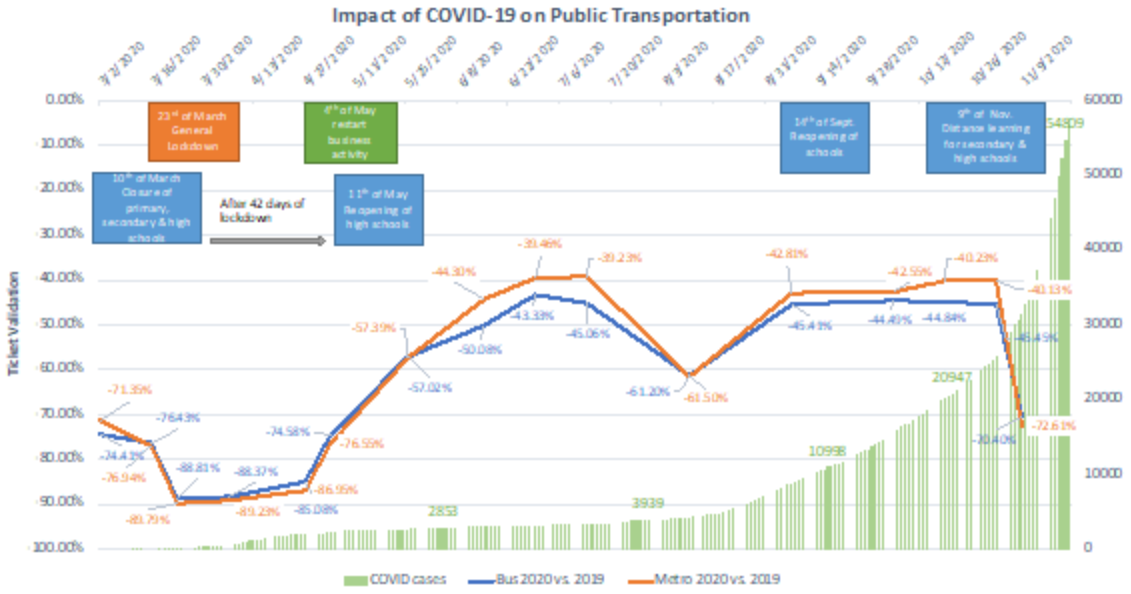


Figure 11. Transport Ridership Reduction due to COVID-19 (raw data provided by OASA, Nov. 2020)

In response to the situation, OASA, the public transport authority for Athens cooperated with the private intercity bus operator (KTEL) via a public-private-sector partnership in which KTEL operates 60 bus lines in the peripheral districts of the city of Athens. The contract has a duration of two years and it stipulates that KTEL will operate 200 buses with 550 drivers on a daily basis on these lines. This frees up 160 vehicles and 327 daily shifts that will be used to improve the headways on bus and trolley lines serving the city centre, and for redesigning its bus network to respond to challenges such as social distancing, which almost halves the transport capacity. As additional measures to deal with the capacity deficit, OASA is planning to procure 300 further buses through a leasing scheme, and to hire 609 additional drivers and technical stuff via fast-track procedures. With regards to the metro operations, in order to avoid overcrowding on public transport amid the coronavirus pandemic, the frequency of services has been significantly increased. Finally, a Demand Response Transport (DRT) bus line pilot was launched at the end of 2020. DRT lines might be safer PT alternatives, achieving the social distancing required (2 meters) between passengers. Finally, the Greek Government has launched a tender for the renewal of the urban bus fleet. Trials of electric buses will be carried out until the end of June 2021, to enable smooth implementation of electromobility with the appropriate infrastructure and vehicle-charging options in place, after the trial period (OASA, Tzivelou, 2020).

Travel restrictions during the lockdown have also affected private car usage. Figure 7 provides the relevant traffic figures on the Attica Tollway. Attiki Odos (AO) is a motorway extending 70 km that constitutes the ring road of the greater metropolitan area of Athens and the backbone of the road network for the whole Attica Prefecture (www.aodos.gr). As shown in Figure 7, an 80% reduction in traffic (from the same period of 2019) took place on the AO during the first period of hard lockdown. After the lockdown, traffic increased rapidly with an average of 20% lower than the same period in 2019, which when compared to the 40% reduction in PT for the same period, indicates that car is the preferred mode of transport during the pandemic. With the new lockdown in October 2020 traffic was approximately 70% lower, a lesser reduction of traffic than that during the first lock-down.

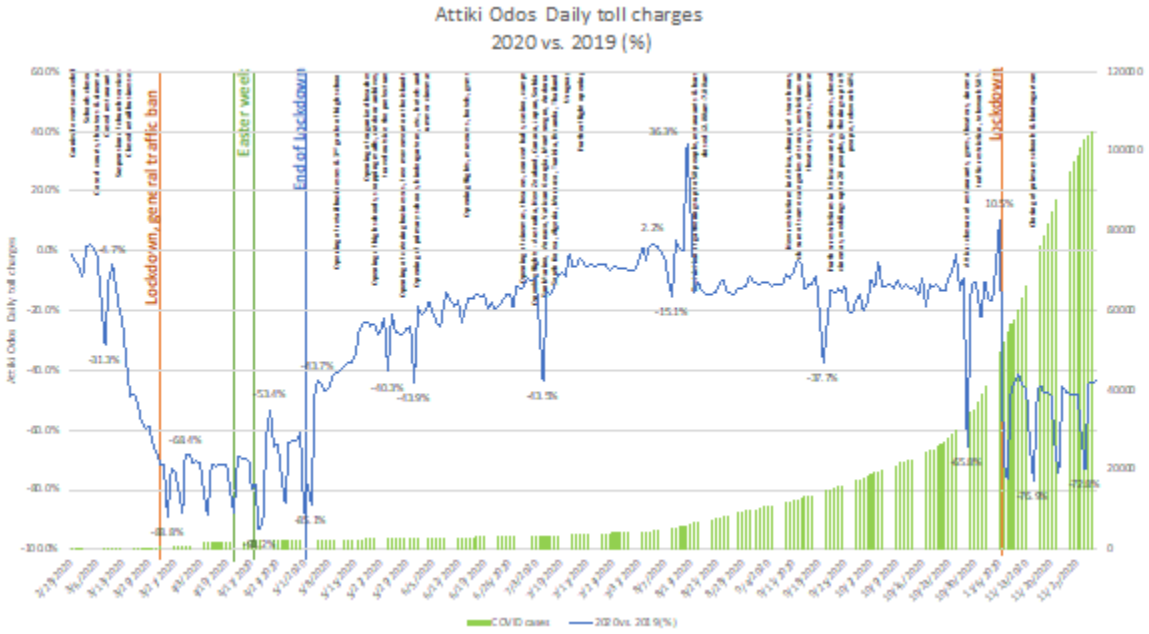


Figure 12. Attiki Odos traffic reduction due to COVID-19 (raw data provided by Attikes Diadromes, Nov. 2020)

When it comes to the measures applied by transport companies to deal with the impact of the pandemic, most of them adopted teleworking procedures as well as adapting their operations to this work from home paradigm. Attikes Diadromes applied an alternate work program by using a teleworking platform, utilized back-up solutions for the Traffic Management Centres, limited maintenance and construction to essential works, suspended or limited the operation of the Customer Service Centres, created new back-up solutions for the Customer Call Centres, and encouraged the drivers to prefer either the ETC lanes (use of transponders) or contactless transactions on POS (Attikes Diadromes, Chalkias, 2020).

All the above measures and responses to the COVID-19 pandemic, as well as the new trends that have rapidly developed, are expected to have a long-term impact on the Sustainable Urban Mobility in the city of Athens. It is anticipated that in the period after the COVID-19 pandemic, the public and private transport sectors will operate more efficiently. Citizens will most likely change their travel patterns to more active modes, which if managed successfully by the city and the providers of transport services, should bring a greener mobility landscape. However, many challenging questions around shifting mobility patterns and the factors driving modal choice are yet to be answered.

Madrid temporary bus lanes to improve service offer

The COVID-19 pandemic has seriously affected collective public transport (PT) in Madrid, with similar difficulties across Europe and the world.

To tackle them EMT Madrid (Madrid Public Transport Company) implemented an integral package of measures, including, coordination activities, specific protocols, daily disinfection plans, contactless payments at all buses (forbidding cash payments), limiting bus capacity, modification of bus lines and creating new ones, making mask use mandatory, setting flexible bus lines driven by volunteer bus drivers, pushing new MaaS functionalities, launching a new "hands-free" unlocking system for bikes at BiciMAD (bike sharing system), etc.

In terms of mobility measures, one is particularly significant, which is the extension of bus lanes to facilitate the circulation of buses, directly influencing the improvement of commercial speed and, therefore, the supply of necessary additional seats (an increase of 32,000 places), ensuring social distancing is possible.
In May 2020, Madrid City Council together with EMT Madrid, deployed 45 km of temporary bus lanes to promote the use of public transport, increasing the existing network by 30%, creating a total of 193 km of reserved bus lanes in the city.

Figure 13. New pop-up bus lanes (marked in yellow) implemented in May 2020 which have been turned into permanent ones by November 2020
Source: Madrid City Council and EMT Madrid, 2020.

The new bus lanes are divided into three lines of action; within the M-30 (first ring road) with 8.5 km; in neighbourhoods outside the M-30 with 17.8 km and in new urban developments with 19 km.

These new bus lanes were a provisional measure to confront immediate needs due to the pandemic. However, having analysed the results of their implementation, in November 2020, Madrid City Council decided to turn the new 45 km of lanes into permanent fixtures and to plan a new extension for 2021, as part of the commitment of the City administration to achieve sustainable mobility and to improve the resilience of the city, helping to reach air quality targets included within the Madrid 360 Environmental Sustainability Strategy.

2.3 Urban freight logistics

Resilient urban freight planning is a challenging task for all city authorities. Due to the competitive nature of the sector and the fact that city authorities frequently do not pay attention regarding the current state of their cities urban logistics systems, the policy response is usually slow and fragmented, affecting the **reflectiveness** of the system.

Only few cities have a **robust** plan for sustainable urban freight. This is mainly due to limited capacity and knowledge of city administrators regarding this field, and a general lack of data.[105] Implementing measures for sustainable urban freight requires collaboration amongst actors in a very competitive industrial sector.

The difficulty of developing appropriate resilient urban freight plans usually lies in breakdowns in communication among the different types of stakeholders involved, a lack of understanding among city authorities on the main characteristics and influencing factors of their urban freight systems, failures in resources allocation, and a lack of transparency in decision-making.[106]

On the other hand, urban freight transport is inherently **flexible**, and at least at the present time, **redundant**. During the COVID-19 pandemic, the field also showed **resourcefulness**, maintaining levels of service most of the time.

One of the main factors towards successful, resilient planning for both passengers and freight is to follow a collaborative and interdisciplinary planning approach, which also promotes **integration** between both systems (cargo hitching). Then, resilient planning for urban freight does not differ from any urban mobility planning.

Especially in urban freight transportation planning, the involvement of different stakeholders in policy making only enhances the resilience and **robustness** of policy measures. This means that the city needs to develop, if it does not already exist, a specific methodological framework for cooperation with related stakeholders.

Dealing with COVID-19

In terms of urban freight transportation, the outbreak of COVID-19 has had a disruptive effect. On the one hand, the demand for B2B city logistics services decreased significantly; on the other hand, national lockdowns led to an e-commerce increase[107]. This massive increase in demand without prior notice has been a great burden for transport operators, who have struggle to manage this increase with limited assets and resources.[108]

The closure of hotels, restaurants and cafes in many major cities incentivised restaurants to use existing e-commerce platforms (i.e. UberEats) or to establish their own delivery channels. These initiatives remain heavily fragmented and operate on the local level without reaching high optimisation of flows.[109] In parallel, the increase in teleworking combined with a substantial decrease in passenger traffic resulted in lower congestion levels and easier parking for urban LVs. In parallel, COVID-19 has increased public awareness of the need for more sustainable, zero-emission transport.

Coping with the challenges posed by COVID-19 required not only resilient services, but also resilient tools. Commercially, cargo bikes have helped cycle logistics operators complete first- and last-mile deliveries in cities where a pre-existing cycle logistics framework had been established. Similarly, municipalities themselves have found cargo bikes to be useful tools in times of crisis, using them to deliver essential goods to residents in need.[110]

In addition, the use of AVs can address resilience challenges posed by COVID-19 in urban freight, especially in times where demand is much higher, and transport operators are struggling to keep-up with expected levels of efficiency and effectiveness in their logistics operations.

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[105] ALICE/ERTRAC, Truly Integrated Transport Systems for Sustainable and Efficient Logistics, 2014, http://www.etp-logistics.eu/wp-content/uploads/2017/03/Truly-integrated-Final-Edition-WEB.pdf

[106] Desouza, K. C., 2012, Leveraging the wisdom of crowds through participatory platforms: Designing and planning smart cities. Planetizen: Planning, design & development, www.planetizen.com/node/55051

[107] FEVAD, 2020, Key figures for e-commerce, – SIRET 784 854 994 00034; Politecnico of Milan, 2020, Osservatorio eCommerce B2C.

[108] TRAN Committee, 2020, COVID-19 and urban mobility: impacts and perspectives, Rapid-response briefing, Policy Department for Structural and Cohesion Policies Directorate-General for Internal Policies, PE 652.213

[109] ALICE (2020). COVID-19: actions to prevent an ecological second wave in the Supply Chain. https://www.linkedin.com/pulse/covid-19-actions-prevent-ecological-second-wave-supply-fernando-liesa/

[110] CityChargerCargoBike, cyclelogistics.eu

Automation in urban freight transport could also reduce personal interaction in the supply chain, which is crucial to decreasing the spread the virus during the pandemic.

When thinking about the post-COVID era, many city authorities are assuming that their residents will continue taking advantage of current pandemic habits (e.g. teleworking, digital solutions adoption). This is leading them to further develop e-commerce and adopt new and more environmentally sustainable solutions, such as deploying IoT networks for smart loading/unloading operations, lockers for B2C deliveries and even delivery drones. However, monopolies in last-mile logistics markets, with no policy intervention, may force traditional shops in city centres to close (SPROUT D3.1).

Short term measures

To address challenges for resilient urban freight planning and effective urban logistics operations in higher demand periods, many cities across Europe are implementing several additional measures. Some indicative measures are:

- Provision of information policies on safety procedures for using logistics public infrastructure.
- Promotion of micro-consolidation services such as e-lockers, macro hubs and micro depots for facilitating socially distanced deliveries, while minimising external costs.
- Provision of zero-emission vehicles (such as cargo bikes) for public social workers to ensure the supply of materials and goods to vulnerable people.
- Expansion of medical and health supply chains using drones for last mile deliveries, to distribute medicine and equipment, while minimising social contact.
- Provision of pre-booked parking spaces for loading/unloading operations.

Box 23: Urban freight best practices examples from the cities of Kalisz (Poland), Mechelen (Belgium) and Rotterdam (the Netherlands)

In the City of **Kalisz** (Poland), the SPROUT project tested a sensor-based booking system for loading and unloading operations serving shops and restaurants in the city centre. This measure promotes social distancing, while reducing the risk of contagion, and thus acts as a resilient planning measure. Detailed examples of such measures are described in the Annex: Case Studies in the current document.

Under the CityChangerCargoBike project, the municipality of **Mechelen** has acquired a fleet of cargo bikes for public works. Although they originally planned to use the bikes for lighter tasks, COVID-19 has demonstrated how resilient and practical these bicycles can be. During the spring 2020 lockdown, Mechelen used cargo bikes to deliver over 500 food boxes to refugees and other vulnerable residents, deliver over 200 laptops to families in need to transition to e-learning, and distribute textiles to volunteers making masks and PPE in a time of need.

In **Rotterdam**, the HARMONY project is testing the inclusion of autonomous vehicles in city logistics. The use of AVs can address the challenges of COVID-19 in urban freight, the need for increased efficiency and automation of deliveries due to increased demand, reduced noise and environmental impact and, above all, can reduce personal interaction in the supply chain in order to avoid the spread of the virus.

Long term measures: aiming for Resilience

This section provides recommendations for long-term resilience in the framework of a city's own urban freight work and addresses topics on which current or future SUMP/SULP planning cycles should focus, in order to secure resilience of city logistics planning.

The process for developing a resilient policy response during and following the pandemic can be summarised in the following steps:

Step 1: City authorities identify the main opportunities and obstacles created by a crisis towards the implementation of a sustainable UF transportation system: To ensure resilient planning during a crisis, the city authority should have quick access to all data necessary for identifying the current state of the city logistics system, and thus the opportunities and obstacles created by crisis. It is well known, however, that the competitive nature of the sector makes data collection by a city authority quite challenging and resource- and time-consuming. The SULP Topic Guide and best practices are useful resources on how a city authority could achieve better data access. However, during a crisis, time is not in anyone's favour. Thus, emphasis needs to be given to the employment of on-demand data collection techniques. Smart tools and the use of intelligent transportation systems are currently the main facilitators of progress in this area.

Step 2: City authorities then reassess the current UF policy framework: It is crucial for each city authority to have an inter-departmental core team, which has relevant domain experience and is familiar with UFT policy and regulation frameworks.

Step 3: A deep understanding of new consumers' needs and preferences – which might remain after the pandemic – is established: Before making any further decisions, it is necessary to develop post-crisis scenarios of the new city logistics ecosystem. Ideally, the development of scenarios together with citizens and stakeholders would be the most effective approach. However, at the moment of crisis, the city authority should be able to quickly develop these scenarios internally.

Step 4: Develop corrective or even additional resilient, long-term policy measures for stimulating the economy, supporting the efficiency and effectiveness of the transport sector, and for promoting the sustainability of the sector during the pandemic: Following this process, a city authority will be able to implement any corrective or additional actions for enhancing the resilience of existing policies or creating new ones. To capture the impacts of COVID-19 and strengthen the economy, actions towards 1) the integration of land use and transport planning, and 2) building data-driven capacity to identify, track and deploy innovative urban mobility solutions, are both necessary. The HARMONY and SPROUT projects provide specific directions, guidelines and tools for achieving this.

New technologies and services will be pivotal in defining the future of urban logistics. Among the new technologies that will affect logistics, automation will be at the centre. As cyclist are today's symbol of alternative delivery options, the future will see automation also playing an important role, with electric robots and drones increasingly occupying pavements and the urban sky. A potential successful long-term measure is the inclusion of autonomous vehicles in city logistics, following the examples of Padua (Italy) and Rotterdam (the Netherlands) from the SPROUT and HARMONY projects respectively.

Drones and Automated Guided Vehicles for last mile deliveries

HARMONY and SPROUT

Small parcels with medicaments will be transferred from the Trikala logistics centre to the villages, where there is a high elderly population. Currently medicines are delivered once a day via vans to the villages. Potentially drones would allow more frequent and on-demand deliveries of the medicaments as well as facilitate the delivery of the medicaments to the villages in the winter, when weather conditions often create difficulties for road transport. The need to expand medical and health supply chains has emerged as a key societal need due to COVID-19 and might help with distribution of medicines and equipment.

Currently, Oxfordshire is investigating the capacity for drone demonstration in Milton park. Drones will then deliver freight packages within the inner area of this business park. As it is within an inner area of a business park, internal traffic on its roads can be controlled.

In the framework of SPROUT project, the city of Padua is testing modular electric self-driving pods for cargo hitching. The vehicles connect the freight village at the outskirts of the city with the city center. In addition to self-driving and electrification features, the system is characterized by the concept of (dynamic) "modularity". It consists of a mixed freight/passenger transport system (cargo hitching) composed by modular electric self-driving pods capable of joining and detaching while running. "Modules" carrying passengers and goods are combined based on estimated flows, which are calculated in real-time by algorithms considering final destinations by users and freight. Such technological and operational features dramatically improve the overall resilience of urban supply chains and the city's ability to cope with COVID-19 related issues.

Effect of the pandemic on Valencia's (Spain) pilot case tested in SPROUT: e-lockers in metro stations

SPROUT

COVID-19 related restrictions has increased the volume of online shopping as people turned to e-commerce. The pandemic also increased amount of time spent at home, incrementing home deliveries with couriers. The implementation of e-lockers could significantly increase the resilience of the city and contribute to the maintenance of economic activity related to e-commerce, promoting social distance while reducing the risk of contagion. E-commerce is one of the sectors that is best resisting the economic crisis. The temporary closure of shops or capacity restrictions, as well as the aforementioned fear of contagion, favoured e-commerce. Individuals who initially were not potential users of e-locks, could now be more interested in using them.

Regarding the most appropriate policy response accompanying these measures, the city intends to foster the implementation of safety procedures in public transport and good information policies on public transport safety in the face of COVID-19 to support the use of public transport (this would increase the number of users of the lockers since are located in metro nodes). This way the frequency of public transport will be increased while maintaining security measures and distances between users. Thus, the use of private vehicle is expected to be decreased.

For promoting e-lockers the city intends to increase the deployment of the e-locker implementation in other public spaces as well as the two metro stations where they are applied currently.

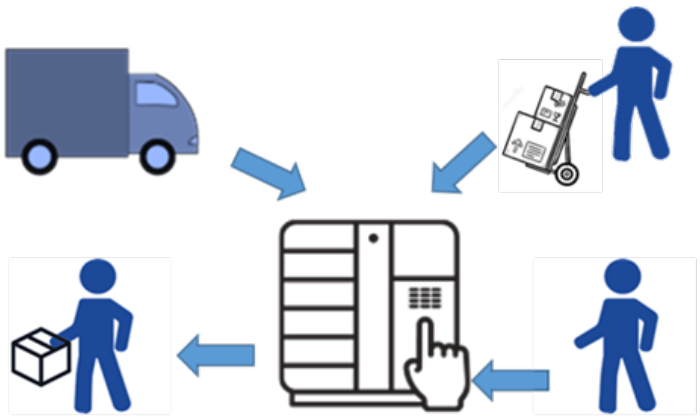

Figure 14. e-locker interactions diagram, SPROUT project

Tactical Freight Simulator (TFS) developed in the framework of HARMONY project

HARMONY

At this stage of the pandemic it is hard to predict how urban freight flows will evolve and how much of the market share e-commerce has gained it will manage to keep. Therefore, cities need tools that help them provide accurate predictions for the various possible Unified Functional Testing (UFT) scenarios related to COVID-19. Towards this direction, HARMONY project develops a new generation of harmonized spatial and multimodal transport planning tools which comprehensively model the dynamics of the changing transport sector and its spatial organization. Urban freight transport is explicitly explored through HARMONY via the development of a Tactical Freight Simulator (TFS). The TFS is a multi-agent simulation model of urban freight transport demand that addresses all stakeholders and the heterogeneity in the decisions of all UFT actors such as firms, consumers and carries and logistics service providers. Via the TFS, policy makers are able to accurately calculate the impact of possible policies.

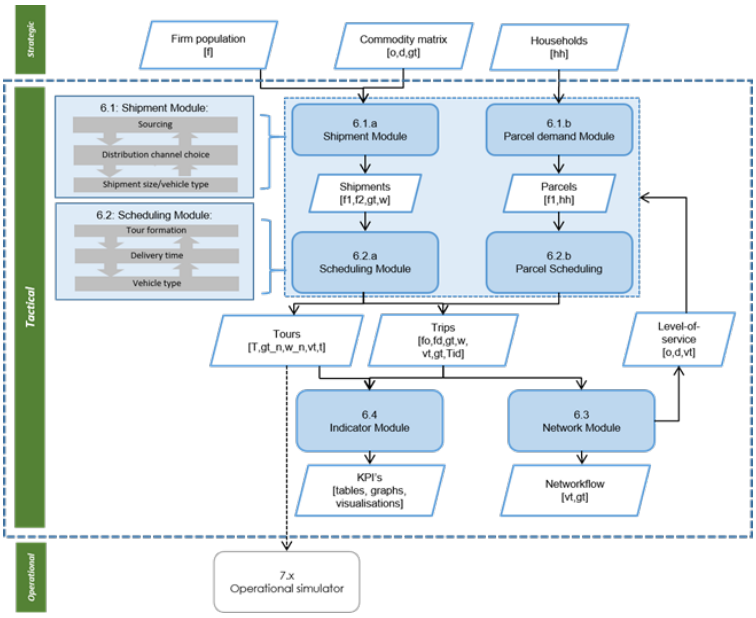

Figure 15: Tactical Freight Simulator Algorithm, HARMONY project

The TFS explicitly simulates the demand for both parcel and other type of freight related shipments. The TFS is also equipped with two scheduling modules which simulate the daily schedules for the delivery of all shipments and parcels that are transported to/from within the study area. It is designed to operate as a single simulator for urban freight demand, but it can work together with other simulators in the HARMONY model suite. The TFS provides input to the operational simulation of vehicle movements and receives inputs from the tactical simulator on regional freight demand and a synthetic firm population.

The TFS is also equipped with two auxiliary modules. The indicator module: used to calculate the Key Performance Indicators for transport and logistic efficiency and the network module assigns freight traffic to the network and calculates emissions. The route choice information is first used to calculate generalized transport costs in the logistic choice models in TFS. In addition, the truck assignment is used to perform a novel emission calculation, considering the vehicle characteristics, the load of the vehicle and the type of links along its path.

2.4 Demand Management Strategies

2.4.1 Urban Vehicle Access Regulations (UVAR)

The pandemic has shown that UVAR measures and strategies are not just a trend, but a necessary step towards developing **sustainable and resilient** cities. The scope of UVAR is broad and does not only include technological solutions and environmental zones – rather, measures range from different types of zero-emission and low-traffic zones, to financial schemes, superblocks, geofencing or pedestrian zones, and more.

With this **diversity** of measures, there is no single recommendation to be made for resilient planning. But, in general, the health crisis has demonstrated that we need to implement UVARs and that cities could more easily react to the crisis if they already had these measures in place, or even **integrated** in a broader strategy. The integration of SUMP and UVAR, for example, provides a planning framework for better prioritisation or postponement of measures. It can also offer a structure of existing stakeholder groups or communication procedures which can be tapped in times of crisis.

Closing streets to motorised traffic, setting up pop-up bike lanes, or widening walkways all are **flexible** UVAR measures that were implemented quickly in reaction to the crisis. But, "high-tech" solutions can also act as flexible schemes – an emergency air pollution scheme for example, or a geofence, are fed by real-time data and can be adapted to react to certain situations. If a system is already in place, such as a low-traffic zone, it is easier to adapt and expand its conditions, for example through granting additional exemptions and permits.

Some cities showed the ability to **reflect** on their UVAR strategy during crisis. London (UK) lifted its congestion fee as a reaction to an increased need for alternatives to public transport and the difficult economic situation for many citizens resulting from the crisis (**inclusiveness**). Other UVAR strategies, such as vehicle-restricted areas (ZEZ, LEZ, LTZ) or superblocks are designed to be **robust** in the face of crisis. Superblocks for example, are one comprehensive strategy for resilient development, especially in the light of climate change, through creating public spaces for walking and cycling, with greening and cooling concepts (see case study).

These are just some examples of the links between UVAR and resilient development; it is clear that UVAR measures are key to working towards creating cities with space for active transport and high quality of life. They contribute to creating a healthier urban environment through improving air quality, creating more space for active transport and recreational activities, reducing congestion and noise, and improving road safety.

Concurrently, they help ensure historic buildings are protected, the attractiveness of a city is improved, and emissions are lessened, which is key to tackling the climate crisis. UVARs can also contribute to a more equal and inclusive transport system, which focuses on moving people and goods, rather than moving vehicles. These aspects all play a role in creating a **robust** and resilient city, which is accessible and attractive and offers alternatives in case systems fail.

Dealing with COVID-19

In a remarkably short time, COVID-19 has brought about a change in the way local decision makers and citizens alike see public space. The health crisis has made it clear that urban space cannot be used principally for car movement and storage. The global pandemic has shown the urgent need to create more space for people in cities, not only to increase the liveability of our cities and the sustainability of a mobility system, but now also to comply with physical distancing requirements.

UVAR measures contributed to urban resilience during the COVID-19 health crisis. Many cities across Europe (and beyond) restricted access for car traffic in order to create extra space for people walking and cycling – as well as for general physical activity for people who do not have their own gardens or outdoor spaces. Pop-up measures included reallocation of space to pedestrians, the segregation of bus lanes and the creation of new cycling corridors. Restaurants were permitted to spread out onto sidewalks and road space and parking lanes were turned into queuing space for people waiting to enter shops (see Case Study on the Space to Move tool). While these UVARs popped up as measures to encourage active travel and create more space for people, other UVAR schemes were paused or postponed in response to the crisis.

In Brussels (Belgium), the LEZ was suspended for four months in spring 2020.[111] In London, the congestion charge – as well as the LEZ and ULEZ – were suspended for two months. This was done to allow essential workers to get to work in the absence of sufficient public transport. As congestion began to increase again, Transport for London reintroduced the charge, offering reimbursements to essential workers.[112]

Short term measures

Having access regulation schemes in place is a good jumping-off point, on which to add or adapt emergency measures. If a city wants to be well prepared, it needs to know what options are available and how current schemes can be adapted in a crisis.

Box 24: UVAR best practice examples from the cities of Padua (Italy) and Bielefeld (Germany)

The two ReVeAL pilot cities **Padua** and **Bielefeld** have both adapted their UVAR strategy in the context of the pandemic. While Padua decided to focus on tactical urbanism measures in their new superblock, Bielefeld used pandemic-related discussions about social distancing to develop a comprehensive concept for restricting motor vehicle access in the old town area.

Figure 16. Visualisation of Bielefeld's old town (City of Bielefeld)

Within **Padua's new superblock,** space will be reallocated to increase road safety and liveability for residents, children, elderly people, pedestrians, cyclists, etc. Instead of using "gates" with cameras to control access to the superblocks, Padua will use street furniture as a physical barrier to restrict access for vehicles. Through-traffic will be limited through a new circulation plan.

In **Bielefeld**, newfound openness among stakeholders and citizens increased motivation to make a change in the old town area. The new concept for the area includes the integration of **modal filters** to further reduce traffic, improving quality of life and road safety. In the pilot area, regular vehicle access will be restricted, while retractable bollards will enable access for deliveries, emergency vehicles etc. and permits will be granted for necessary access to the area. This will be complemented by additional measures such as speed reduction, reallocation of space, improvement of bicycle infrastructure, and the establishment of delivery zones.

Free use of public bicycle sharing systems was also provided to health workers.[113] In addition, authorities decided to delay the implementation of new rules tightening emission standards in the LEZ in London by four months to ease pressure on the freight industry during the health crisis.[114]

A city can more easily react to a crisis if it has flexible UVAR schemes already in place and additional options in store.

The ReVeAL project has identified and structured 68 UVAR measures into four categories (see box 25). Each measure is a building block (e.g. a parklet) that moves in the direction of a larger vision (e.g., superblock). These could include, for example, parklets, urban freight regulation, or measures that help implement an aspect of a controversial LEZ (e.g. a logistics hub). Understanding the UVAR building blocks available to a city will help them decide which ones may be appropriate for them, not only in crisis situations.

111 "Violating Brussels' LEZ will be fined again from July", Brussels Times, 2020, https://www.brusselstimes.com/brussels/114318/violating-brussels-lez-will-be-fined-again-from-july/

112 Transport for London, 2020 https://tfl.gov.uk/info-for/media/press-releases/2020/june/temporary-changes-to-the-congestion-charge-to-secure-safe-recovery

113 Sustrans, Cycles for Key Workers in London, 2020, https://www.sustrans.org.uk/campaigns/cycles-for-key-workers/cycles-for-key-workers-in-london

114 London City Hall, MD2690 LEZ 2020 Postponement, 2020, https://www.london.gov.uk/decisions/md2690-lez-2020-postponement

Box 25: ReVeAL UVAR measures

Spatial interventions: access regulations based on area planning and design, and physical interventions in the public realm, e.g., school street, cycling street, traffic filter, removing parking or road space, cycling lanes

Pricing measures: financial charging for access to specific areas, e.g., congestion charge, pollution charge, parking charge, urban logistics charge

Pathways towards LTZ/LEZ/ZEZ: zones where all vehicles need to meet a set emission standard (LEZ/ZEZ) or zones that can only be entered with a granted permit (LTZ), e.g., regulation by emissions, regulation by vehicle type and/or dimensions, regulation by trip purpose, regulation by time

Future options: possible tools and emerging technologies that cut across all measures, e.g., geofencing, connected vehicles, dynamic traffic signalling

The following table presents a selection of possible short-term measures, based on the ReVeAL methodology.[115]

Table 9: UVAR building blocks for short term implementation

Measure field	UVAR building blocks for short term implementation
Spatial interventions	**Reallocation of space, tactical urbanism and pop-up measures**: School street, cycling street, traffic filter, removing parking spaces (parklet), cycling lane, pedestrian streets, bus/tram priority lane, shared space
Pricing measures	If a **congestion charging scheme is already in place**, it can be adapted or extended if it is 1) applied to a perimeter, 2) applied to specific points, or 3) a distance-based charge. If a **pollution charge** (applied to a perimeter or an area) is already in place, it can be adapted or extended and can act as a flexible reaction to high air pollution. If **parking charges** (dynamic priced or emission-based) or t**raffic flow management** (time-based charge) systems are already in place, they can be adapted or extended.
Pathways to ZEZ/LEZ/LTZ	If a type of **emission or limited-traffic zone** is already in place, the associated system for **granting access permits and exemptions** can be adapted in order to facilitate the type of mobility required (e.g. permits for essential workers). This applies to regulations by emissions, by vehicle type and dimension, or by trip purpose, regulation by time and regulation by permit.

[115] Please note that only a selection of building blocks can be listed here, the full list is available here: https://civitas-reveal.eu/wp-content/uploads/2020/08/ReVeAL_D2.2_UVAR_set_of_categories_final_for_submission-1-1.pdf

Long term measures: aiming for Resilience

In the long-term, UVAR schemes can contribute to **higher-level goals** such as tackling the climate crisis, working towards vision zero or reducing premature deaths from air pollution. UVAR can also be supportive in **adaptation** to crisis, for example in climate change adaptation to natural hazards or heat waves. The **superblock** model with its greening and cooling concepts is just one example.

Also, future technologies such as **geofencing** are examples of long-term resilience measures. Geofencing can enable a flexible designation of given areas of a city with lower emissions, noise or speed. While geofencing is still a future technology, today **Intelligent Speed Assistance** (ISA) can contribute to creating safer environments through limiting speeds. The ReVeAL pilot city Helmond (the Netherlands) is currently testing this in their city[116]. Urban design and digital aspects of UVARs will need to be coordinated, but this redundancy will mean that one system can also take over if the other fails.

Ideally, long-term measures and their targets and monitoring indicators are embedded in a **SUMP**. This can help a city determine what actions it needs to take if exceptional circumstances arise. If a city – and its citizens – are familiar with access regulations and have already experienced their positive benefits, it will be easier to adapt, explain and implement them as needed, using existing communication and participation structures.

ReVeAL's methodology of defining possible ingredients for an UVAR scheme includes defining building blocks (see above) and futureproofing them. As part of **futureproofing** all ReVeAL building blocks, their resilience towards **future trends and options** was assessed. This method could help other cities to build up a resilience strategy and assess selected measures in the light of different trends and crises.

The ReVeAL building blocks were future-proofed considering a range of trends, including **pandemic, climate change, electric and shared mobility, ride-hailing, an aging population and lower/higher travel demand**. While these trends have a strong mobility focus, for a broader risk assessment they could be complemented by other relevant trends such as natural hazards, urbanisation, energy transition, food security, agricultural productivity, etc. The future-proofing of the UVAR building blocks enabled an assessment of the risks facing the ReVeAL pilot cities' UVAR strategies in the face of future trends. The final future-proofing methodology will be published at the end of the project.

[116] ReVeAl, Helmond tests ISA on Speed Traffic, 2020 https://civitas-reveal.eu/helmond/helmond-tests-isa-speed-traffic/

Superblocks for a resilient city development

ReVeAL

By now, most practitioners and decision-makers in the transport field are aware of the superblocks model. Barcelona has proven that people-centred urban planning is possible through implementing superblocks and is planning many more across the whole city. Other cities have seen the benefits they offer for reclaiming public space for their citizens, reducing motorised transport and promoting active modes[117]. Cities such as Vienna[118] and Berlin[119] are working on adapted versions of the superblock model with pilot implementations. As part of the ReVeAL project, the city of Vitoria-Gasteiz is working on the implementation of two superblocks and acts as a forerunner with further plans of "superblocking" the whole city, which are also integrated into the Vitoria-Gasteiz SUMP[120].

But why are superblocks resilient? It is not a coincidence that Barcelona has extensive plans for implementing superblocks and also has an Urban Resilience department. Barcelona was the first city in the world to establish such a department (launched in 2014), and it joined the Rockefeller Foundation's 100 Resilient Cities Network in the same year.[121] The resilience model aims to build a city with more capacity to face today's and tomorrow's challenges, reduce vulnerabilities, and proactively manage impacts to ensure quality of life.[122] As the main initiative for resilient planning and working towards a healthier built environment, the superblock model stands for prioritising walking as the main transport mode, for creating space and implementing cooling and greening concepts in light of heat waves and climate change. Barcelona's superblock model is a way of showing the world what resilient planning can look like – and how a city can create healthy environments for its citizens. Initial studies reveal that the superblocks can have an enormous effect on reducing air pollution, noise and heat. They also have the potential to prevent hundreds of premature deaths every year.[123]

For more information: https://ajuntament.barcelona.cat/ecologiaurbana/sites/default/files/ModelResilienciaBarcelona.pdf

Figure 17. Sant Antoni Superblock in Barcelona, 2019 (Mueller et al. 2020: Changing the urban design of cities for health: The superblock model.)[124]

[117] Mueller et al. 2020: Changing the urban design of cities for health: The superblock model. In: Environment International, 134, January 2020, https://www.sciencedirect.com/science/article/pii/S0160412019315223#f

[118] https://www.wien.gv.at/stadtentwicklung/projekte/supergraetzl.html

[119] https://changing-cities.org/bergmannkiez-wird-erster-superblock-berlins/

[120] https://civitas.eu/measure/superblocks-model

[121] https://awards.re-thinkingthefuture.com/uncategorized/resilient-cities-and-urbanism-a-case-of-barcelona/

[122] https://ajuntament.barcelona.cat/ecologiaurbana/en/what-we-do-and-why/energy-and-climate-change/urban-resilience#:~:text=Barcelona%20City%20Council%20is%20promoting,city%20residents'%20quality%20of%20life

[123] Mueller et al. 2020: Changing the urban design of cities for health: The superblock model.

[124] Environment International, 134, January 2020, https://www.sciencedirect.com/science/article/pii/S0160412019315223#f

The "Space to move tool" for mapping pop-up measures

ReVeAL

The pandemic has demonstrated the importance of good communication. In the UK, Sustrans has found a methods for collecting information on a range of changes to streets, such as reallocation of space, or pop-up measures, and bring them together in a single interactive map. The Space to Move tool not only provides information about these new measures, it also involves citizens by asking for their feedback. A survey linked to the map enables users to share direct feedback on every measure.

In the context of the ReVeAL project the mapped measures represent collections of different Urban Vehicle Access Regulations (UVAR) measures (called "building blocks" in ReVeAL) which the project has identified and divided into in the categories 1) spatial interventions 2) pricing measures, 3) pathways to zero-emission zones and 4) future options. The Space to Move tool collects information on street space that has been reallocated from car use, to create additional space for pedestrians or cyclists, using measures such as, wider footways, reduced speed limits, protected cycle lanes, restricted through traffic or school streets closed to vehicles. All of these measures are taken up in the ReVeAL project and tested in pilot cities.

The Sustrans tool, with its hundreds of entries, is a visual representation of the wide range of pandemic-related measures taken in the UK, motivated by the gravity of the situation and the urgent need for more space for people walking and cycling. These measures have improved road safety, reduced speed in cities and limited vehicle access to some city streets. While many of the measures, that were implemented in record speed, were designed to be temporary, some of these solutions could be made permanent as part of longer-term strategies to improve active transport infrastructure and road safety in cities.

The Space to Move tool is a project from Sustrans, a UK walking and cycling charity and custodian of the UK National Cycle Network (https://www.sustrans.org.uk/). It can be found at https://www.sustrans.org.uk/space-to-move/.

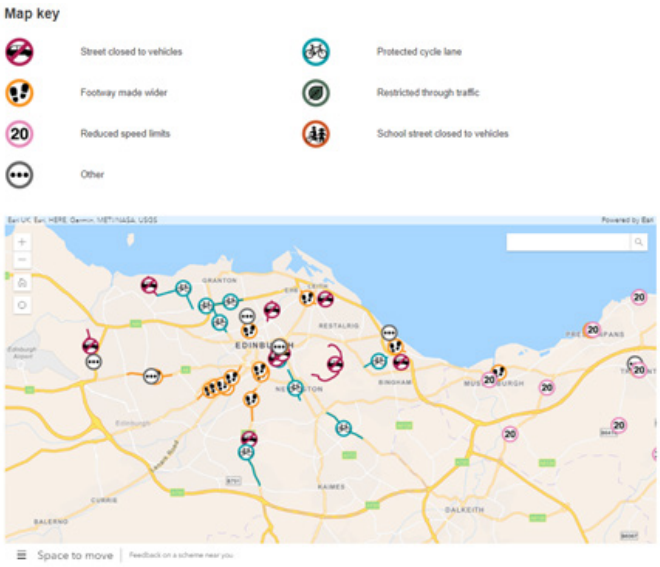

Figure 18. Screenshot from the Space to Move tool: Edinburgh's mapped pop-up measures (https://www.sustrans.org.uk/space-to-move/)

2.4.2 Parking

Effective parking management has proven to be beneficial in realising sustainable urban mobility in our cities. Every car trip starts or ends with a parking spot. Parking space management is thus a key enabler to shift individual motorised trips towards more walking, cycling, an increased use of public transport and more engagement in new mobility schemes (like car sharing or bike sharing systems)[125].

Innovative parking management is part of a wider strategy, which includes promoting active modes, targeting better quality of life and creating more human-centred cities as part of the journey towards zero-carbon mobility[126]. Mobility is critical to the functionality of urban areas. Furthermore, it is a crucial factor in the common challenge that cities face of striking the right balance in the allocation of public versus private space. Using space to ensure accessibility and overall efficiency are of vital importance in cities. A **flexible** and **resourceful** parking policy, acts both to steer an overall mobility system, and can respond quickly to society's changing needs.

High-quality parking management is a main **component** of a reflective mobility system. Better use of urban space can be achieved through curbside management, implementing regulated parking zones and composing parking standards for new developments. Parking revenues can be earmarked to improve and promote (shared) mobility alternatives, to invest in affected city districts, or to support continuous technological innovation[127] [128]. In addition to stimulating sustainable modes, a **redundant** and **robust** approach to parking management anticipates disruptions in the mobility system, such as in times of crisis. Changes in demand for transport can then easily be managed and tailored to societal needs.

An **inclusive** approach can be guaranteed if high quality parking management solutions are integrated in sustainable urban mobility plans[129]. Despite the growing traffic flow of persons and goods, more liveable and attractive urban areas can be created by providing people options to move around easily and efficiently while using fewer resources. The right parking management scheme is the driver of a resilient urban mobility system, in which the value of public space, the interests of stakeholders, sustainable behavioural change, the attractiveness of urban areas, the economic vitality of cities and a climate-neutral vision are explicit.

Dealing with COVID-19

The COVID-19 pandemic revealed the importance of quality public spaces in cities. The obligation of teleworking and distanced learning in a lot of European cities led to travel avoidance. Figures 19 and 20 show how traffic and mobility were affected by the lockdown in Leuven (Belgium) and in Germany.

Many parking facilities were underutilised or even not used[130]; this emphasised why parking standards and effective parking management are beneficial for public space, for revenue, and to accommodate flexible travel behaviour.

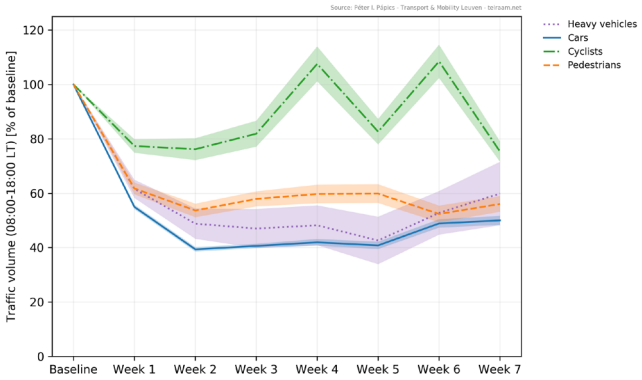

Figure 19. Traffic volumes in Leuven (Belgium) during lockdown periods[131]

[125] European Parking Association, 'EPA Position Paper', 2019, https://www.europeanparking.eu/media/1583/epa_position-paper.pdf

[126] European Commission, 'Sustainable and Smart Mobility Strategy – Putting European Transport on Track for the Future', 2020, https://ec.europa.eu/transport/sites/transport/files/legislation/com20200789.pdf

[127] Park Here, 'SMART PARKING SPACE MANAGEMENT AS AN URBAN CHALLENGE', ParkHere, October 2020, https://park-here.eu/en/smart-parking-space-management-as-an-urban-challenge/

[128] Matthias Finger and Teodora Serafimova, 'EUROPEAN TRANSPORT REGULATION OBSERVER', November 2020.

[129] Park4SUMP, 'Parking Management as Game Changer for Urban Mobility', Park4SUMP, 2021, 4, https://park4sump.eu/

[130] Michael Fousert, 'Monit Reveals the Impact of COVID-19 with Parking Data' (Parking Network, 14 October 2020), https://www.parking-net.com/parking-news/monit/reveals-impact-of-COVID-19-with-parking-data

[131] Pápics, P., WeCount & Telraam, 'Are We on the Way Back to Business as Usual?', 2020, https://telraam.net/en/blog

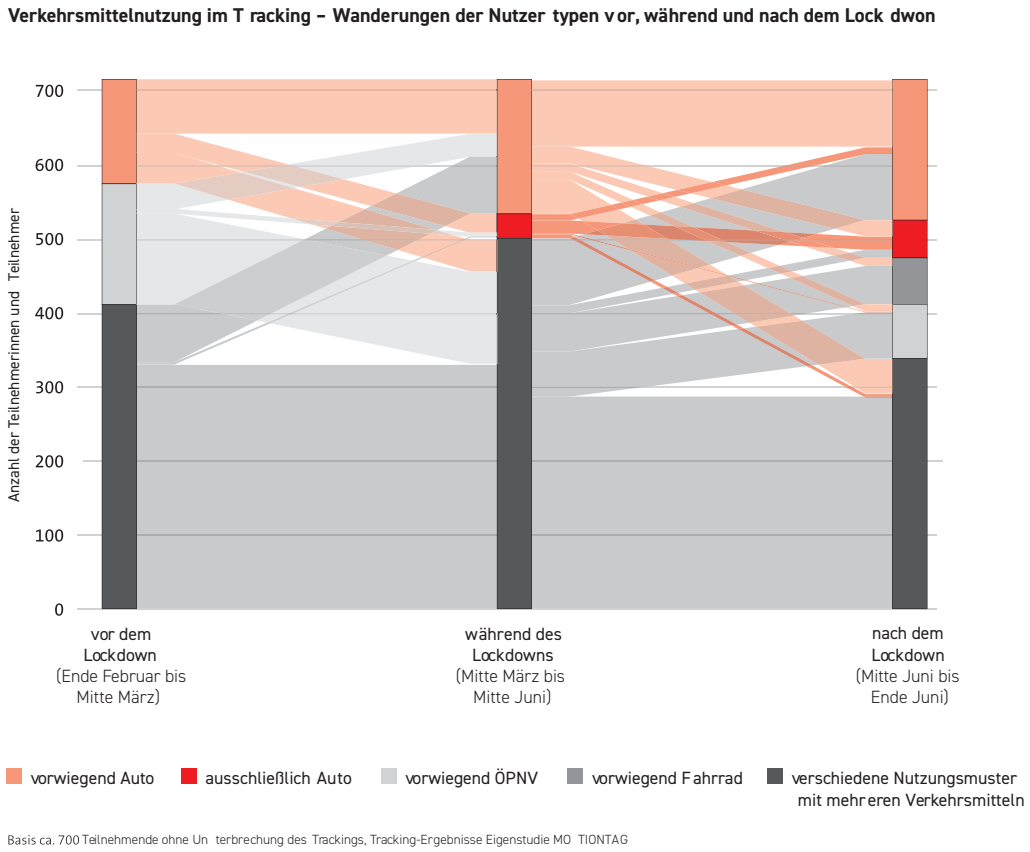

Figure 20. Traffic volumes in Leuven (Belgium) during lockdown periods[132]

COVID-19 also shifted many individuals' focus to the local level, which led to shortened trips or a shift in modes[133][134]. Including all modes of transport in parking policies is essential to facilitate active mobility and to have an impact on car ownership[135]. To this end, the pandemic brought another opportunity: making use of all monitoring and evaluation possibilities to capture consequences of the reset in traditional urban mobility systems.

Many of the good practices during COVID-19 times should be retained in European cities. Community-friendly developments were supported by living labs (e.g. Rotterdam (the Netherlands)), as were other measures to, for instance, promote alternatives to the car, as in La Rochelle (France). Technology meant that knowledge sharing on parking management could continue through the pandemic; however, the crisis slowed the implementation of parking policy measures. Nevertheless, cities are moving and responding to the new normal faster than ever. Integrating parking management into SUMPs is an ongoing process in the short- and the long-term.

Short term measures

In times of crisis, a reset of the urban mobility system can occur. Demand for transport changes due to restrictions, uncertainty about reliable and safe (public) transport systems, and adjusted social policies. This results in different approaches in the field of parking policy.

132 Robert Follmer and Marc Schelewsky, 'MOBICOR_Mobilitätsreport_2_202008017.Pdf', July 2020, https://www.infas.de/fileadmin/user_upload/MOBICOR_Mobilit%C3%A4tsreport_2_202008017.pdf

133 Finger and Serafimova, 'EUROPEAN TRANSPORT REGULATION OBSERVER'.

134 Mobilitätsagentur Wien, 'November: 20 Prozent mehr Radverkehr in Wien', Fahrrad Wien, 15 December 2020, https://www.fahrradwien.at/news/november-20-prozent-mehr-radverkehr-in-wien/

135 Patrick Auwerx et al., 'PARKING AND SUSTAINABLE URBAN MOBILITY PLANNING How to Make Parking Policies More Strategic, Effective and Sustainable', June 2019.

In hard lockdown policies, the free movement of people is heavily restricted. Unforeseen circumstances make cities switch to allow travel for only essential professions. Teleworking becomes compulsory for non-essential sectors. Regarding parking policy, this directly impacts revenue streams – as demand is reduced, parking regulations may be suspended along with associated enforcement. Implementing hard parking policy measures, like introducing paid parking zones in shopping districts, are placed on-hold. Direct consequences of hard lockdown measures include empty streets and empty parking spots. This is beneficial for creating (temporary) infrastructure for slow and more sustainable modes. On a city level, this results in more space for walking or cycling and supports the implementation of bike parking facilities, safe places to meet or business expansion. On the other hand, as revenue streams are cut, this can reduce funding for sustainable alternatives.

Digital opportunities can be used to overcome indirect effects on general parking management, such as by supporting virtual meetings with relevant stakeholders to prevent delays to participatory mobility planning.

With good planning, lockdowns can have some impact on parking policy, but in general, the system can adapt and remain operational. In this case, a relaxation of parking regulations might be an option. Hospital neighbourhoods as implemented in Zadar (Croatia) or residents' areas can temporarily be made free of charge. Another option is that free parking permits be given to health workers (e.g. in Rotterdam). Other cities such as Trondheim (Norway) either have no regulated parking to start with, or have maintained regulations, albeit with reduced enforcement[136].

In general, focusing on the strength of local neighbourhoods spans resilient urban mobility planning. Cities must take this time to think about how to support sustainable and accessible mobility, to avoid people jumping into private cars when lockdown measures are eased. This can be done through the re-allocation of space at the expense of on-street parking, individual traffic lanes and occasionally through street closures.

The reallocation of parking space can take different forms:

- Reallocation to commercial ventures: Businesses are given the opportunity to expand their operation out into the street, helping them remain viable with social restrictions.
- Reallocation to public squares: converting parking spaces into areas for multiple uses.
- Reallocation to lanes for active modes: pedestrianised zones and pop-up bike lanes are a common response to crisis, which shift services from the dominant motorised share towards active means of transport. The importance of an accessible and local urban area is highlighted by the use of more sustainable modes.

Box 26: Parking best practice examples in the cities of Rotterdam (the Netherlands), Reggio Emilia (Italy) and Lisbon (Portugal)

Rotterdam expanded an existing programme that was in place for seasonal terraces, allowing more parking places to be given over for business use without the need to apply for a permit. In these cases, parking is suspended, and those impacted are offered special rates at nearby garages. An additional policy set out in Rotterdam's COVID-19 mobility strategy is the creation of a 'city lounge': an appealing and vibrant city centre. This, albeit temporary, response to COVID-19 is fully aligned with the long-term vision for the city.

Reggio Emilia launched a pilot to transform a parking lot in a city square into a square for people. The city also allowed businesses to use public spaces at no additional cost.

Lisbon doubled the existing cycle path network with pop-up bike lanes. These are expected to become permanent commuter routes. The city now plans to have more than 200km of cycling network by early 2021. This represents a significant acceleration of plans that were already in place.

[136] Susan Tully, 'COVID-19 Impact on Park4SUMP Objectives'.

Long term measures: aiming for Resilience

Generally, the (temporary) short-term measures in response to a global crisis give cities a window of opportunity to fast-track existing sustainable mobility plans. People then have the opportunity to test out what the planned shift looks and feels like. Having a clear vision and plan for a future urban mobility system certainly facilitates an agile response to a crisis. The role parking management has to play in resilient mobility planning then comes to the forefront.

A sustainable transition of the mobility system in the long term can be ensured by following a series of guidelines related to innovative parking management:

1. **High quality parking management respects the need for urban space, providing facilities for active modes and human well-being.**

Ensuring a multi-modal mobility system, in which walking and cycling are the protagonists and public transport is the backbone of the system, requires that public space is efficiently and effectively allocated. Quality walking and cycling infrastructure can be installed at the expense of on-street parking. This includes innovative bike parking systems, designed with enough space, and supportive of a wide diversity of cyclists, placed at mobility hubs and other sites which attract large numbers of people. The way that people have, during COVID-19, conquered public space by using parking spots in diverse ways showcases once again that participatory planning and co-creation are building blocks for future urban mobility.

2. **A resilient urban mobility system includes a strategic parking revenue approach.**

Earmarking the revenue from parking management to sustainable mobility funds is of fundamental importance. In times of crisis, it allows the flexibility to divert available funds to wherever they are most needed. If improving and promoting sustainable alternatives might be politically difficult, stakeholders can use parking revenues to support affected city districts (e.g. creating playgrounds, parks, etc.) or to support social gatherings.

3. **Parking standards strategies account for future urban mobility planning.**

Experience shows that introducing maximum parking standards or tradable parking rights are a controversial issue for local governments. Nevertheless, if people only make essential trips, the minimum parking requirements for cities are exposed. In these cases, it becomes clear that public space dedicated to parking is not used, partly used or used for other purposes. Therefore, parking conditions and requirements during a crisis are a threshold for future participatory processes and planning on a human scale. The real impact on people's travel choices, promoting alternatives like car sharing systems in a neighbourhood, and a decrease in construction costs for new buildings are all tangible options whose potential is made clear during lockdown periods.

Infrastructural measures to deal with the pandemic in the region of Brussels (Belgium)

PARK4SUMP

The Brussels Capital Region responded to the COVID-19 pandemic by taking infrastructural measures. In preparation for increasing travel after the lockdown period, the focus was on active travel modes to discourage people switching to the car and prevent overcrowded public transport[137]. Bike lanes were created on former busy traffic routes, like the Wetstraat. Other parking management related measures were taken in the Lombardstraat, as drop-off zones for scooter and bike sharing systems were created nearby public transport hotspots and public squares.

In terms of enforcement, bicycle staples, additional road signs and plantings of greenery are preventing the illegal car parking near pedestrian crossings, intersections or traffic lights. Parking zones were removed from public squares, such as Koningsplein, and nearby the Sonian Forest to give pedestrians and cyclists freedom of movement. Monitoring and evaluation revealed the communities' needs for more green areas, more space for active modes and child-friendly public space. The main underlying reasons are traffic safety, better air quality and strengthened social contact,- which,even amidst a worldwide pandemic, is important for physical and mental health.[138]

Figure 21. Drop-off zones for step- and bike sharing systems in the Lombardstraat nearby public transport hotspots and public squares - ASBL Quartier Saint-Jacques (Bruzz, 2020a)

[137] Selma Franssen, 'In Lockdown, Brussels Sees a Chance to Fix Its Traffic Problem', City Monitor (blog), 16 June 2020, https://citymonitor.ai/transport/in-one-of-europes-most-car-dependent-cities-lockdown-offers-a-chance-to-rethink-the-road

[138] Bruzz, 'Nieuwe deelstepparking aan elf stations en pleinen', 2020, https://www.bruzz.be/mobiliteit/nieuwe-deelstepparking-aan-elf-stations-en-pleinen-2020-09-29

Smart parking solutions and freed public space capture the City of Rotterdam (the Netherlands)

PARK4SUMP

In times of crisis, Rotterdam documented a reduction in parking activity across the city[139]. In response, the city supported local businesses by giving them permission to expand into the outdoor space or create terraces. This allowed companies to remain operational and limit the damage to the local economy. Residents were also given greater access to public space in the city. Parklets freed up public space by ensuring the multiple use or replacement of parking spots[140]. People could voluntarily design and use the public space, by creating playgrounds, more green areas, bike parking facilities or citizen gardens. Even though the experiment has ended, people now have the opportunity to request a transformation of an on-street parking spot in front of their doorstep[141] [142].

Additionally, more efficient parking management in the region was provided by using scan cars. In this way, technological measures helped to enforce parking regulation in a safe way. The scan cars are compatible with the parking sensors already installed in certain zones. Those sensors ensure the monitoring of occupied and free parking spots in city districts. With the help of the scan car, the local government can check if vehicles are parked legally, the fee is paid and the permitted parking time is respected. This technological measure shows how the substitution of human resources in terms of parking enforcement can be beneficial in times of crisis. Furthermore, Rotterdam launched a pilot study with a parking app to reduce the traffic created by difficulty finding a parking space and to evaluate the current parking policy in city districts.

Figure 22. Businesses extend into previous parking spots in Rotterdam (City of Rotterdam, 2020)

Figure 23. Scan car in Rotterdam (Park4SUMP, 2019)

[139] Susan Tully, 'COVID-19 Impact on Park4SUMP Measures', April 2020.

[140] Arnarsdóttir Hörn, 'Rotterdam Offers Free Parklets to Help Local Businesses Turn Parking Spots Into Terraces', Pop-Up City, 6 August 2020, https://popupcity.net/observations/rotterdam-offers-free-parklets-to-help-local-businesses-turn-parking-spots-into-terraces/

[141] Gemeente Rotterdam, 'Aanvragen fietsvlonder | Rotterdam.nl', productbeschrijving, Gemeente Rotterdam, 2021,https:/www.rotterdam.nl/loket/aanvraag-fietsvlonder/

[142] Vitibuck, 'Burgerinitiatief "Hofbogen Tavolata"', Vitibuck, 2020, https://www.vitibuck.nl/en/burgerinitiatief-hofbogen-tavolata/

2.5 Electromobility

Electric mobility is a quiet, zero emission transport option, unlike mobility services driven by combustion engine vehicles. As a result, it contributes to a healthy urban environment and the overall quality of urban space for citizens.

The technological shift from internal combustion engines to electric vehicles is facilitating new forms of mobility services through light electric vehicles (LEVs). These LEVs hold a special role in urban mobility services during the pandemic, particularly in their ability to cater to individual mobility needs and in their capacity to serve shifting demands and gaps in the public transport network. The integration of LEVs into Mobility as a Service (MaaS) options provide added **flexible** mobility options during this public health emergency.

Using locally-produced renewable energy for e-mobility contributes to the cutting of CO2 emissions and generates energy independent mobility options, which increase the **robustness** of a city. It can also result in added economic benefit. High-scale deployment of electromobility (e.g metro, tram, bus) has the potential to contribute greatly to the overall resilience of cities. Electromobility remains the best solution to achieving the climate and industrial ambition outlined in the European Green Deal for transport. This ecosystem is crucial to Europe's economic relaunch in the aftermath of COVID-19 and will create over one million jobs in vehicle and rail manufacturing, charging infrastructure deployment, and supply chains, such as for batteries, by 2030.[143]

Dealing with COVID-19

At the beginning of the COVID-19 crisis, with most cities and regions going into lockdown, the minimal need for mobility services resulted in a drastic drop in demand for electromobility. For instance, some e-scooter operators took the drastic decision to completely shut down operations and remove their vehicles from the streets in several cities around the globe.[144]

[143] Platform for Electromobility, European Green Deal and Green Recovery: time to focus on Electromobility, 2020, https://www.polisnetwork.eu/wp-content/uploads/2020/06/European-Platform-for-electromobility%E2%80%99s-position-on-Green-Deal_FINAL-2.pdf

[144] McKinsey, The impact of COVID-19 in future mobility solutions, 2020, https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-impact-of-covid-19-on-future-mobility-solutions

Once restrictions began to lift however, there was an evident increase in LEV demand, even surpassing pre-COVID-19 demand levels. To explain this phenomenon, several reasons have been pointed to, mainly: the acquisition price of LEVs has lowered; LEVs are open air vehicles that can be disinfected easier than cars; infrastructure for LEVs has advanced; and awareness of LEVs is becoming more mainstream.

Box 27: Electromobility best practice example in the region of Ile-de-France (France)[145]

The region of Ile-de-France is encouraging post- lockdown mobility through a range of measures focused on e-bikes. Their 'Veligo' e-bike rental scheme (considered the largest in the world) provides 10,000 e-bikes for hire across the region – a number which will eventually increase to 20,000. One month of e-bike use was offered free of charge to all subscribers, while 200 bikes were made available free of charge to health workers. **Ile-de-France** is currently covering 50% of the costs for the purchase of e-bikes, which will soon be extended to all bikes. Whilst plans to expand the use of e-bikes were already in place, the situation with COVID-19 has expedited the process.

[145] POLIS, The post-lockdown strategies of Rome and Ile-De-France, 2020, https://www.polisnetwork.eu/news/post-lockdown-mobility-webinar-report-the-post-lockdown-strategies-of-rome-and-ile-de-france/

As individual mobility modes have become more popular during the pandemic due to perceived unsafety of public transport and shared modes, cities have experienced a visible increase in foot and bicycle traffic. The usage of private cars has also risen. This has negatively impacted the growth of sustainable modes and slowed the revitalisation of cities that aspire to higher living quality of public space. Although forced confinement has resulted in dramatically cleaner air, these improvements are highly correlated with the absence of fuel burning vehicles on the road. A drastic shift towards electric mobility is necessary in order to ensure that previous progress towards sustainability is not derailed by this new individual mobility trend.

Short term measures

The rise of active mobility caused by the pandemic could be the perfect opportunity to incentivize the use of electric bikes. As the global e-bike market is projected to expand rapidly, now is the time for local authorities to invest in infrastructure, such as bike highways with wider and safer paths.

In the short and medium term, measures should be undertaken to increase the demand for clean mobility and zero emission technologies. Local, regional and national authorities should provide stimulus to accelerate the uptake of electric cars, vans and trucks by public and business fleets, as well as for personal mobility.

Short term measures might be less relevant in the field of electromobility -compared to other measure fields discussed in this document - but in the longer term, it is expected that electromobility will be accelerated due to COVID-19, as car manufacturers redesign themselves and cities experience cleaner air. In the meantime, public authorities should focus their efforts on drawing roadmaps and building strategies to facilitate the transition towards electromobility. Planning processes should not be underestimated as collecting data and cooperating with relevant stakeholders will be key in the planning of a seamless transition towards user-centric electromobility.

Long term measures: aiming for Resilience

Zero-emission mobility plays a vital role in the improvement of air quality in cities, and is therefore a building block for public health and the increase of resiliency.

Despite good progress[146], further efforts are needed to achieve a reduction in car ownership and to make greater use of Mobility-as-a-Service and shared mobility in the future. Cooperation between cities and taxi and ride-hailing companies in mapping out the demand for charging points will be pertinent for increasing the electric share in taxis and ride-hailing companies. Drivers need time to become accustomed to the transition to EVs, and increasing the convenience of EVs by expanding charging infrastructure will aid this transition.

In the field of urban mobility resilience, **resourcefulness** implies that people and institutions can rapidly find different ways to achieve their goals or meet their needs during shock or when under stress. To increase resourcefulness in electromobility, cities need to invest in the capacity of the network to anticipate future conditions of grid vulnerability. Indeed, decentralised renewable energy production and usage is essential for a fast uptake of zero-emission transport and related applications without being bound by public grid limitations.

Cooperation among public and private actors, including charge point operators (CPOs) and distribution system operators (DSOs), will be essential to facilitate the transition towards electromobility.

Public authorities should focus their planning and pilot projects in the following fields:

- Developing smart charging technology, such us battery swapping stations, wireless charging, charging points in lamp posts
- Ensuring interoperability across all e-systems
- Optimising the allocation of charging stations within an area or region based on road network capacity, distribution network adequacy and local societal needs
- Balancing and increasing grid capacity to make the most of local and renewable energy production
- Improving charging technology planning, booking and payment servicesReallocation to lanes for active modes

The Sustainable Transport Forum provides recommendations for public authorities on the procurement of charging infrastructure.[147]

Finally, SEAPs (Sustainable Energy Action Plans) and SUMPs (Sustainable Urban Mobility Plans) are strategic plans that, although from different perspectives, share the same goal: reducing pollutant emissions and promoting sustainable urban development. As SEAPs and SUMPs influence each other, a coordinated and integrated approach in the form of harmonised planning will maximise possible synergies. This **integration** needs to be done in tandem with increased electrification of energy infrastructure and transport together with the local and central electricity grid as part of the move towards a "smart grid".

[146] International Transport Forum, Shared Mobility Overview: growth, trends and indicators, https://www.itf-oecd.org/sites/default/files/docs/overview-shared-mobility-growth-trends-indicators.pdf

[147] Sustainable Transport Forum, Recommendations for Public Authorities on Recharging Infrastructure https://ec.europa.eu/transport/sites/transport/files/sustainable_transport_forum_report_-_recommendations_for_public_authorities_on_recharging_infrastructure.pdf

2.6 Transport telematics

The availability of transport data is crucial for both private and public stakeholders. The private sector uses data to enable new business models and to provide services to users, while the public sector uses it for planning better services and to monitor the transport network and its externalities (air quality, noise). The availability of such data is possible only with the deployment of technology (sensors, connectors, data warehouses) and through proper management (data governance, training of human resources).

In the wake of COVID-19, measures to limit and control movement have been utilised widely. Given how they track and map people's movements, ITS and data have provided crucial evidence to inform cities' responses. The trajectory of increasing technology in cities has usually followed the goals of efficiency and **integration**. The pandemic has shown how efficiency and integration can help with other public objectives such as limiting interaction via social distancing.

Transport telematics help build resilience at the city-level by using data to continuously assess transport system usage and flows, which in turn influence transport operations and structure. Transport telematics also provides cities with tools to increase resilience in a medium degree by providing a **robust** design of transport systems, providing **redundancy** and diversity in terms of transport modes, for example by the implementation of MaaS. By connecting the transport system through data, it also provides the city with resources so that users can efficiently find travel alternatives.

The principles of **inclusiveness** and **integration** are central to the planning and implementation of transport telematics. It is crucial that all city services are aligned via a sweeping common vision, which will ensure greater collaboration and potential for cross-service support.

ITS and MaaS platforms directly enable transport system **flexibility** and **robustness**, as well as collect vast amounts of data that can provide precise and up-to-date information about travel demand patterns under both normal and disruptive circumstances. The deployment of such technology within the public sector can also help in emergency contexts, such as for decision-making by police.

Decision support tools can improve the mobility experience of citizens by supporting policy and decision making. Artificial Intelligence-based data analytics and new modelling capabilities will allow planners to have a better understanding of the impact and implementation pathway of new mobility schemes. Data-driven insights and Operations Research techniques will allow cities to be more so as to react faster and more efficiently to disruptions of any kind. In addition, simulation models will give detailed insights and refined results about how and where to implement on-demand and sharing mobility schemes that aim to reduce congestion and minimize the environmental footprint of mobility services in the city.

Dealing with COVID-19

COVID-19 has had severe impacts on the demand side of public and private transport, leading to strong behavioural changes of travellers. These changes have forced MaaS operators to develop new functionalities, business models and features of their solutions, with the aim of lowering risk and creating business sustainability.

According to the qualitative analysis from the GECKO[148] project, MaaS companies are reinventing business models to address changing demands. For example, some companies have included new value-added information, such as frequency of cleaning per day, crowd level and social distance, to their systems.

[148] GECKO project website, http://h2020-gecko.eu/

In addition, MaaS companies have started to diversify their service portfolios and create "crisis packages" to deal with different short-term regulatory measures, since temporary regulations might exclude some core services. Several stakeholders suggested that, "2-3 pandemic scenarios should be prepared to respond the changing demands (e.g., 20% of people will be working remotely)".[149]

Restrictions and adaptations of mobility conditions were some of the first policy responses during the pandemic. Some of these included: a halt in cash payments for travel in preference to new electric and contactless ticketing solutions; ridesharing services being used more by key workers and for deliveries; and micromobility redevelopment towards further accessibility.[150]

COVID-19 impact on mobility also demonstrated the need for a resilient transport system, accelerating the deployment of MaaS solutions, as they are able to adapt the transport offer very fast with the disrupting changes of our daily routines. But this requires a collaborative policy strategy and setting-up public-private partnerships.

Short term measures

The deployment of tactical data-driven responses to disruptions requires a good knowledge of the available data sources and their potential to assess management strategies. A key success factor for this is to take advantage of research initiatives and available funding to explore the use of new data sources collected by ITS and mobile devices under normal circumstances, so that transport managers are ready to use data when it is urgent to do so. In a post-lockdown world, mobility solutions must ensure critical mobility components are addressed, like the health and safety of commuting. Increased shared mobility solutions could relieve some pressure from public transport while keeping their users safe as it can be easily disinfected at the end of the trip with UVC lights.

Box 28: Best practices in the field of transport telematics around the globe[151]

Logistics companies in Italy have introduced new protocols for contactless unloading of goods, thereby removing the need for a personal signature. Beijing has introduced a digital booking system for tracking movements. Catalonia has introduced a new app for online tracking of public transport loads in order to reduce congestion and develop individual routes for passengers.

Drone technology has both supplied "contactless" medical deliveries in China, Ireland, Ghana and USA, as well as conducted enforcement and disease-spreading surveillance during lockdowns in France, India, Italy, Greece. Other automated vehicles were also used for the delivery of goods deliveries.

Data-driven businesses have demonstrated their support to local authorities regarding decision-making through continuous reporting , such as data-sharing between UK's Department of Transport and ITS UK.

151 International Transport Forum, 2020, Drones in the era of Coronavirus https://www.itf-oecd.org/sites/default/files/drones-covid-19.pdf;

ITU News, 2020, Where are the self-driving cars and trucks? https://news.itu.int/covid-19-where-are-the-self-driving-cars-and-trucks/;

Shotl, 2020, How overcoming COVID-19 can kick-start the MaaS revolution https://shotl.com/news/how-overcoming-covid-19-can-kick-start-the-maas-revolution;

Le Parisien, 2020, Versailles Grand Parc welcomes Wever, the platform that informs you of live traffic https://www.leparisien.fr/info-paris-ile-de-france-oise/transports/versailles-grand-parc-accueille-wever-la-plate-forme-qui-vous-informe-du-trafic-en-direct-04-06-2020-8330001.php

149 GECKO deliverable 'Stakeholder dialogue Workshop #2'. See the table page 43-44: http://h2020-gecko.eu/fileadmin/user_upload/GECKO_D5.3_Stakeholder_dialogue_workshop_2_summary.pdf

150 McKinsey, The Impact of COVID-19 on future Mobility Solutions.

Long term measures: aiming for Resilience

Multidisciplinary staff training in institutions with transport management responsibilities is an important success factor for the development of resilience strategies. The exploitation of new data sources can benefit from teams and profiles in the intersection of data science and transport planning. Modelling tools can support the development of decision-making processes targeted towards the adoption of resilience strategies. Modelling allows transport planners to assess and communicate the impacts of future scenarios to all stakeholders.

There is an insufficient amount of detailed data that can be integrated into operational models at metropolitan networks, indicating a defined area for improvement. If the goal is to improve transport models it is necessary to increase investment in technology and knowledge, as well as knowledge among the public sector on how to capture such valuable data.

Thus far, most of the models have been developed with private, conventionally-fuelled vehicles and public transportation modes as the most utilised means of urban transport. Now, as new mobility technologies, services, and concepts continue to emerge, the existing models used for integrated land-use and transport are rendered not wholly capable of realistically ascertaining the likeliest impact of new technologies and services, such as autonomous vehicles, drones and MaaS.

From a technical perspective, the integration of large-scale land-use and activity-based transport models requires a high quality and volume of data. Common ways to store and share micro data should, therefore, be defined. In addition, research on integration approaches between independently developed and autonomous models is ongoing. Additional research is necessary to identify the main requirements for computationally efficient integration of models that allows for the testing of different spatial and transport planning policy scenarios.

Additional long-term recommendations include:

- Fostering further public-private cooperation in order to develop a sufficient regulatory framework for MaaS deployment;
- Incentivising policies in the B2B sector that encourage a shift among employees towards more sustainable transport – MaaS offers a flexible and adaptive solution to accomplish this[152].

[152] "COVID-19 and new mobility services : what changed in private-public cooperation ? – Key takeaways", UITP, 2020, https://www.uitp.org/news/understanding-the-mobility-ecosystem-with-uitps-combined-mobility-manager/

Data applied to find solutions in Madrid (Spain): mobile network data and the use of longitudinal data sources

MOMENTUM

The Spanish Ministry of Transport and other local and regional institutions are using origin-destination matrices extracted from anonymised mobile network data to monitor mobility patterns. The information is provided by the SME Nommon, a data analysis and artificial intelligence specialist, involved in several European research projects including H2020 MOMENTUM to develop new data analysis techniques for travel demand.

The raw data consist of a large sample of anonymised registers from mobile devices, covering a broad range of demographics. The observed trajectories are processed to reconstruct active-travel diaries and identify door-to-door trips, regardless of the transport mode used. By extrapolating the resulting active-travel diaries to the total population, it is possible to anticipate demand patterns in metropolitan areas within only 3-4 days of delay. This has enabled transport authorities to perform dynamic assessments of the measures put in place, increasing system resilience by identifying which areas require additional services to reduce contagion risk in public transport vehicles. A key factor driving the success of these initiatives is that many authorities had previously worked with this data source under normal circumstances, so transport managers were ready to fully utilise the information. This highlights the benefits of adopting innovative approaches to data collection in the transport sector.

Once the severe lockdown was lifted, many transport services registered major increases in their demand. The public bike sharing system broke its trip record with more than 17,000 trips in June 2020

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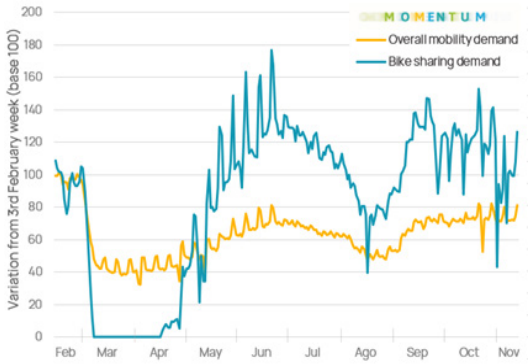

Figure 24. Variation in overall mobility and bike sharing demand from February to November 2020 (base 100 at 3rd week)

Figure 17 shows the differences in the evolution of total trips and bike sharing trips in the city. This suggests bike sharing is playing a role in deterring the modal shift from public transport to private cars, thus contributing to the system resilience.

The Decision Support Tool (DST) can define a set of measures to promote mobility means of transport to keep physical distancing and avoid highly crowded mass transport vehicles to reduce virus spread. With mobility data collected, the DST can provide data driven approaches to the decision makers, through AI and OR (Operational Research) techniques implemented. On demand and shared mobility systems can be an quick and safe measure to tackle the pandemic crisis and increase city's resilience.

Monitoring mobility in real-time in order to make more resilient planning decisions: the example of Turin (Italy)

HARMONY

Since the start of the pandemic, the city of Turin has been tracking its mobility flows through a real-time monitoring system using existing sensors. The objective is to quantify the impact of confinement measures that strongly affected citizens'' mobility since the March 2020 lockdown. The scheme includes more than 1,000 sensors documenting car traffic, and 6 sensors on bike paths. Several indicators were used to describe mobility variations and significant trends.

At the end of March, results showed that average urban traffic dropped by 60% during working days and 72% during the weekend. Bike trips dropped by 70%, while the use of public transport (tickets validations) declined by 86% during the week. Today, the monitoring system continues to generate thousands of data and allows stakeholders to understand how mobility is evolving (e.g. cycling seems to represent a more attractive option at present).

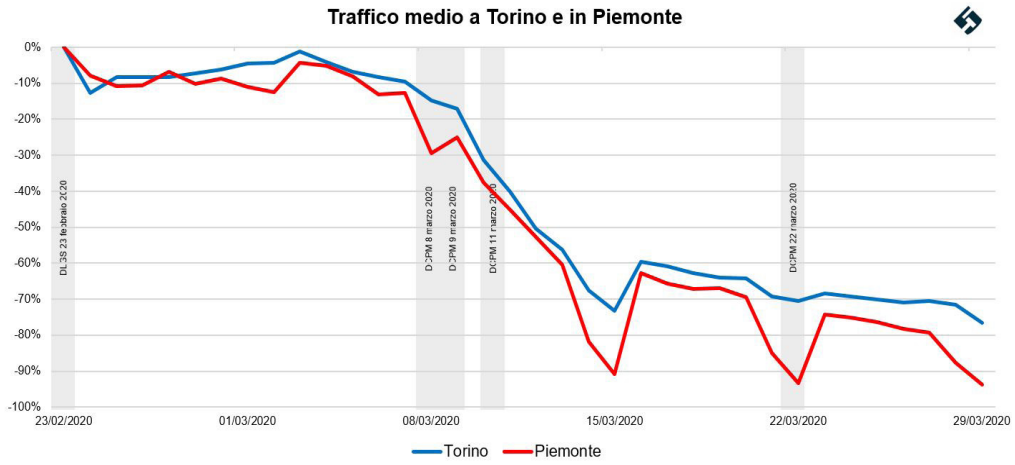

Figure 25. Impacts on average daily road traffic (number of vehicles per day on the road network) in the City of Turin and Piedmont Region between 23/02/2020 and 29/03/2020, following national confinement measures.
Source: Data elaborated by Turin's "Centrale della Mobilità" managed by 5t, 2020.

In addition to reacting to challenges posed by the pandemic, the opportunity to monitor traffic data in real time is an important instrument enabling authorities to take more immediate and appropriate planning decisions. Being able to rapidly identify and trace changes in mobility and respond accordingly is critical to resiliency.

The impact of COVID-19 on individual and collective travel behaviour and lifestyles, presents the opportunity to rethink urban mobility; tailoring services to citizens' needs could be one of the positive side effects of this pandemic. Using real-time transport telematics to gather data, as Turin did, could be a key element enabling this change.

2.7 Road safety

Across the EU, our mobility system still cause around 25.000 deaths and 135.000 seriously injured people each year,[153] negatively impacting the liveability of cities and causing changes in travel behaviour (e.g. parents can be very reluctant to let their kids cycle to school). Because of this, safety is declared as being the central focus of EU mobility development in numerous forums and in key policy documents. One thing is clear: systems can be only sustainable and resilient if they are also safe.

Safety is therefore strongly linked to the ambition to make our mobility system robust and resilient, addressing possible changes in the way our mobility system is used or can be used. The Safe System approach is the EU's primary path towards Vision Zero – no mobility-related deaths and serious injuries – and it outlines a shared responsibility among those who design, build, manage and use roads and vehicles. This inclusive approach will lead to a more robust and resilient system that prevents collisions resulting in serious injuries or deaths, provides post-collision care, and foresees that people make mistakes and that user conduct can change because of new behavioural rules or habits.

Europe included this approach in its main policy strategy and highlighted the key steps forward in its EU Road Safety Policy Framework 2021-2030. Evidence of this approach is already given with the efforts to implement measures in this way in Sweden since 2000 resulting in among the lowest levels of road deaths and serous injured e.g 2.2 road deaths per 100,000 inhabitants in Sweden in comparison with 3.7 in Germany, 5.0 in France and 5.2 in Italy, 7.7 in Poland.[154]

Dealing with COVID-19

The COVID-19 pandemic has had an immediate impact on the functioning of our multi-modal mobility system. The limitation of our activities has resulted in fewer persons and goods moving around; yet, simultaneously, by following the safety guidelines outlined by virologists and politicians, a general shift in perception of the various transport modes has changed how the mobility system is used. This has had a strong influence on traffic safety and the number of deaths and seriously injured people following a collision. The table below gives an overview of the mechanisms that were observed during each COVID-19 infection flow, resulting in an impact on safety.

Figure 26. Road safety class in school Source: (Rethymno Municipality)

[153] Road Safety: Encouraging results in 2016 call for continued efforts to save lives on EU roads, Press Release, 28 March 2017, https://ec.europa.eu/commission/presscorner/detail/en/IP_17_674

[154] ETSC, 2019, https://etsc.eu/13th-annual-road-safety-performance-index-pin-report/

Table 10: COVID-19 impact on safety

COVID-19	Influence on mobilty	Impact on safety
Lock-down effects: more homebased activities (economic, education, leisure, etc.)	• Less passenger and goods transport • Less traffic on the roads • Higher speeds	• Fewer collisions* • Fewer deaths and serious injuries* • More severe collisions*
Increased positive perception of cycling and walking (individual, in open air, healthier, etc.)	• Higher share of cycling and walking in daily trips • More cyclists** on narrow cycling paths, on limited infrastructure	• Potentially more collisions with cyclists ***
Increased negative perception of public transport (in a closed space, close to other users, etc.)	• Lower share of public transport in daily trips • Fewer users of public transport	

** In April 2020, an unprecedented reduction of 36% in road deaths was observed, compared to the same month in the three years prior in 25 EU countries for which data was available. The overall number of collisions was reduced significantly, but there are indications that collisions became deadlier as the share of drivers exceeding the speed limit increased, e.g. overall collisions across France fell by 74% while road deaths decreased by 56%.*[155]
*** Eco-Counter registered an increase in monthly cycling levels in October 2020 by 48.4% in Italy, 34.4% in Portugal, 18.8% in Finland and Sweden, 16.8% in France, and 16% in Spain, compared to October 2019.* [156]
**** There are currently no clear observations that the increased share of cyclists has led to an increased number of collisions, however more riders using less than optimally infrastructure will potentially lead to more collisions.*

Short term measures

As a reaction to the changing mobility demand, many local authorities took additional measures to give cyclists and pedestrians increased space and better cycling and walking conditions, for example:

- Temporary enlargements of pavements and increased space on the road to facilitate active mobility
- Increased number of parking places for bikes, replacing car parking places
- The conversion of car lanes and parking spaces to pop-up cycling lanes
- Pop-up waiting areas at the entrance of shops or other activity places, reducing the space used by cars
- Reduced vehicle speed limits in areas with increased walking and cycling (introduction of 30 km zones or lower for specific living zones)

These measures have a particularly positive impact on road safety for active modes, since they allow for the allocation of additional space for pedestrians and cyclists. Furthermore, zones with limited speed reduce the risk of collisions and reduce the risk of deaths and serious injuries after a collision.

[155] PIN Briefing, The impact of COVID-19 lockdowns on road deaths in, April 2020, https://www.efa-eu.com/wp-content/uploads/6-ETSC-covd-19-PIN-lockdown-report-final-07-09-2020-with-EL-data.pdf

[156] Eco Counter, Bike count dashboard: tracking the growth of cycling by country, 2020 https://www.eco-compteur.com/en/cycling-data-tracker/

Box 29: Road Safety best practices in Europe (Paris, Milan, Brussels and Mechelen)

Paris introduced 650 kilometres of cycleways – including a number of pop-up "corona cycleways" for the use of key workers and others during the lockdown. Elsewhere in France, 116 towns and cities – including Lille, Dijon, Rouen, Le Mans, and St Etienne – have built temporary cycleways for the duration of the current lockdown and the following few months.

Milan has gone from traffic jams to silent streets in a few weeks during the COVID-19 lockdown. After the lockdown, Milan's authorities announced that the city will be introducing one of the most ambitious schemes in Europe to reduce traffic congestion in the city centre. The new scheme will include low-cost temporary cycle lanes, new and widened pavements, 30 km/h speed limits and pedestrian and cyclist priority streets.

Brussels integrated a pop-up two-way bicycle path on the main car thoroughfare entering the city. Furthermore, a new 20 km/h speed limit inside the inner ring of Brussels was implemented during the lockdown.

Mechelen converted cycling paths into pedestrian zones and car roads into bicycle roads, allowing for decreased car use and a prioritisation of active transport modes.

Long term measures: aiming for Resilience

Mobility experts argue that the 'temporary' measures taken as a reaction to the COVID-19 situation can and should trigger an increase in resiliency and robustness in our mobility systems for the long term. This is certainly applicable for road safety, where consistently high numbers of mobility-related deaths and injuries reinforce the need for safer mobility systems. This crisis can be harnessed as the momentum needed to make an enormous step towards the Vision Zero ambition.

Elements of such an approach are already in the temporary pop-up measures proposed as a reaction to the current COVID-19 crisis. These measures should result in a multi-modal mobility system, where public transport, walking and cycling act as the backbone, and car use as supportive supplement.

The following principles can guide this ideal future:

- Cycling and walking should be a strong structural system capable of providing mobility for all, regardless of age, accessibility requirements, skill levels, etc.
- Road networks should be transformed so as to provide sufficient space and safe interaction points for cyclists, where new behavioural rules are enforced and a high awareness of safe behaviour is standard.
- The criterion used to determine vehicle and cyclist speed limits should start from the most vulnerable participant in each public area. The implementation of lower speed limits should not be dictated by only infrastructure development, but can already be implemented if supported by increased awareness, acceptance campaigns and focused enforcement efforts. The speed limit of 30 km/h can be used as a starting point, to then be increased or decreased depending on the amount of pedestrians and cyclists in the zone.
- Parking policies should respect the need for public space in urban areas and should prioritise parking needs for bikes.

Finally, to ensure that these short-term measures trigger a sustainable transition that will continue beyond the COVID-19 crisis, evaluation activities and awareness-raising campaigns are crucial.

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