ReVeAL

Regulating Vehicle Access for improved Livability

Milestone 11 – Report

Initial Assessment of Resiliency of Pilot Cities' Regulatory and Policy Measures

Authors: WSP Sweden

Date: 30 May 2020

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 815008.

Table of Contents

Summary sheet

Milestone No.	11
Project Acronym	ReVeAL
Full Title	Regulating Vehicle Access for improved Liveability
Grant Agreement No.	815008
Responsible Authors	Moa Berglund and Julie Schack (WSP Sweden)
Peer Review	Lisa Marie Brunner (Rupprecht Consult), Koos Fransen (Ghent University), Lucy Sadler (Sadler Consultants)
Date	May 30, 2020
Status	Final
Work Package No.	2
Work Package Title	Reviewing UVAR options and building scenarios
Programme	Horizon 2020
Coordinator	City of Bielefeld
Website	Civitas-reveal.eu
Starting date	01 June 2019
Number of months	36

About ReVeAL

ReVeAL – Regulating Vehicle Access for Improved Liveability – is a CIVITAS project funded by the European Union's Horizon 2020 research and innovation programme. The goal of ReVeAL is to add Urban Vehicle Access Regulations (UVAR) to the standard range of urban mobility transition approaches of cities across Europe. The EU funded R&I ReVeAL project looks at this hot topic for the first time since the CURACAO project (ending a decade ago).

The overarching mission of the project is to enable cities to optimise urban space and transport network usage through new and integrated packages of urban vehicle access policies and technologies. Such policies can lead to fewer emissions, less noise and improved accessibility and quality of life, which especially benefits the people living in these cities. These policies can also encourage more sustainable transport choices, enabling cities to become more liveable, ultimately healthier and more attractive for every member of society.

To this end, ReVeAL combines conceptual work and case study research with hands-on UVAR implementation in six pilot cities, as well as systematic stakeholder interaction through professional communication activities. Different UVAR measures will be developed, implemented and tested in the cities of: Helmond (NL), Jerusalem (IL), London (UK), Padova (IT), Vitoria-Gasteiz (ES) and the project leader Bielefeld (DE). Except these cities, the project partners are Centro de Estudios Ambientes (ES), Ghent University (BE), Universitá di Padova (IT), POLIS (BE), Rupprecht Consult (DE), Sadler Consultants (DE), Transport for London (UK), TRT (IT), V-Tron (NL) and WSP Sweden (SE). The project started in June 2019 and will run for three years.

ReVeAL looks at a range of UVAR measures, both established and cutting-edge approaches, grouped under the four *Measure Fields*:

Pathways Zero-emission zones / Low-traffic zones
Areas that are regulated by rules, e.g. where only vehicles emitting zero emissions, or low emission are permitted or a traffic limited zone.

Spatial interventions
Access regulations based on area planning and design, and physical interventions in the public realm.

Pricing measures
Financial charging for accessing specific areas.

Future proofing and future options
Possible tools and emerging technologies that cut across all measures.

Milestone description

Milestone 11 is part of task 2.6 – *Future proofing UVARs* which is the main activity of the measure field *Future proofing and future options*. This task is carried out in two parts:

1. Innovation Observatory report and city-specific readiness assessment: The observatory will cover both mobility products and services (their market penetration and potential transportation and societal impacts) as well as the potential of new technology (its potential business models). Key suppliers and developers will be consulted. With the knowledge gathered during the design phase in task 2.4, the Task Leader will perform an initial assessment of the resilience of each city's regulatory policies and measures. The assessment covers existing policies, those under consideration and potential transition schemes and possible future adaptions. A final assessment will be made halfway through the (WP3) implementation.

2. Future ready guidelines: These will be an extract and generalized practice-based lesson from both desk research and the pilot cities. The guidelines will feed into the online Decision Support Tool and support European cities beyond the consortium.

Milestone 11 is an initial assessment of the resilience of each pilot city's regulatory policies and measures, to be finished in month 12 in the format of an assessment report. The assessment concerns the resilience of regulatory policies and measures for future trends and options in services, technology and transition schemes and is based on knowledge gathered during the design phase in task 2.4.

Partly covered by the final assessment that will be made halfway through the implementation (as mentioned above), the task of future-proofing UVARs will continue throughout the entire ReVeAL project, and feed into the pilot cities' support processes but also the decision support tool that will be developed in WP5. Thus, these activities will not be concluded by this milestone report, and it should be read as a description of the initial stage of the future-proofing and resiliency assessment process.

The benefit of the initial assessment for the pilot cities is to provide input to their design and planning of UVAR measures, to increase, if possible, the future readiness of their actions.

Method

In work package 2, UVAR measures have been defined in the form of *building blocks*, that are described in a database. Each city can combine several building blocks that together define their UVAR strategy. Building blocks exist in all four measure fields – spatial interventions, pricing measures, pathways to zero/low-emission or low-traffic zones and future options. There are also a few complimentary measures[1].

Some minor edits have been made to the list of building blocks in the UVAR database, when using it in the assessment. Since many building blocks are very similar, some of them have been merged to facilitate the process, where it has been judged to not alter the result of the assessment.

The initial assessment has been carried out in two parallel processes:

1. The resiliency assessment of each building block
2. The mapping of which building blocks each pilot city is planning, considering or already have existing

When the results of these are merged, they result in:

3. The resiliency assessment report for each pilot city.

Resiliency Assessment of each Building Block

As mentioned above, it is the resilience for future trends and options in services, technology and transition schemes that is to be assessed. To structure the assessment, a framework of these types of trends and options has been assembled from three main sources:

1. The technology areas identified in the market consultation on new technology, products and services (milestone 10)
2. Discussions in the consortium during spring 2020 about the need for reviewing UVAR measures in the light of future pandemics

[1] A complimentary measure is a building block that does not categorise under any of the measure fields, but is typically introduced in parallel with the other building blocks to increase their efficiency or compensate stakeholders that are negatively affected by the UVAR measures. At the time for the data collection and analysis for this report, the complimentary measures were not yet included in the building block database. Therefore, they have not been included in the initial assessment. However, if pilot cities on their own initiative included any complimentary measures in their reporting, they have been included in the analysis.

3. A set of “external forces” identified in the Scenario Development Tool which is part of WSP Scenario Planning Toolbox, which aims to be an exhaustive list of trends and developments in the world which can affect transportation and infrastructure in a region

The long-list of trends/aspects/developments (from now on only called “trends”[2]) from these three sources was refined at a future-proofing workshop held at WSP in May, where some trends were removed and others added.

The removed are trends that are typically either:

- important for a region’s economy or demographics, but their impact regarding traffic and mobility in a city is hard or impossible to predict. This does not mean they will not affect travel/transport patterns and demand, but the effects, in the light of UVARs, are unclear. For example: Sharing Economy refers to “economic activity based around the concept of shared access to assets and services rather than ownership”. This will probably lower some of the transports of goods to and from stores. On the other hand, the shared assets may still have to be transported between the users, or the users will have to move to the assets. The net effect for an UVAR is not clear enough to include the trend in the analysis.
- affecting the travel demand generally, in either direction. For example, ”Urbanisation” could increase travel/transport demand in the city since the population increases. On the other hand – in a dense city, many services and jobs can be found close to people’s homes and decrease the demand for travel. Likewise, “Advanced automation” could lead to rising unemployment, which could decrease commuter trips. On the other hand – people may need to travel longer distances to find a job. Therefore, these trends have not been selected. Instead, two new, merged trends were introduced: “Higher travel demand” and “Lower travel demand”.
- have a negligible or hard-judged effect on the city-level traffic volumes. For example, the trend “Global Outsourcing/Re-shoring” could have massive impact on a region or a city, but in the light of UVARs the important thing would be how it would impact traffic flows, which is difficult to judge without detailed knowledge of the specific city. As another example, the trend “Agricultural Productivity and Food Security” is likely to have the largest impact on transport patterns outside of the cities.

In the table below, all considered trends/aspects are listed and the ones selected to be used in the assessment are marked with an “X”. For the selected trends, it has also been briefly described how they have been assumed to mainly affect the range of building blocks.

[2] A “trend” is here regarded as the future development of a real-world factor in a certain direction that seems likely or possible today.

Table 1: Long-list of trends that have been considered for the resiliency assessment.

Trend	Description	Source	Selected
Automation	The automation of vehicles to become driver-less in the long run. Already covered by "Autonomous and Connected Vehicles" below.	ReVeAL Innovation Observatory	
Positioning	Vehicles being equipped by positioning devices which enable new implementation of UVARs such as geofencing. Unproblematic from a resiliency perspective - skipped.	ReVeAL Innovation Observatory	
Connectivity/ IoT	Vehicles and infrastructure being connected and sharing data between them. Already covered by "Internet of Things (IOT)" below.	ReVeAL Innovation Observatory	
Dynamic control	The controlling of equipment/vehicles but also traffic flows and more through smart algorithms. Unproblematic from a resiliency perspective - skipped.	ReVeAL Innovation Observatory	
Future pandemic	How will a new pandemic, like COVID-19, which has large effects on how people and goods move, affect the UVARs, in terms of effectiveness, utility, technology being used, etc.? Assessment focus on physical distancing with active modes, avoidance of public transport and safe transport of critical staff and materials.	Requested by ReVeAL consortium	X
The Gig Economy	Describes a trend towards the emergence of more casual temporary and/or flexible employment style, and more generally a shift from permanent, full-time work to temporary, contract, and freelance work, often underpinned by digitisation. Assessment focus on less reliable/recurring travel patterns.	WSP Scenario Planning Toolbox	X
Advanced Automation	Automation of employment across sectors. This could take varying forms depending on the sector, and could include a combination of technologies including artificial intelligence and advanced robotics.	WSP Scenario Planning Toolbox	
E-Commerce	Refers mainly to retail transactions conducted over the internet for the purchase of goods and services. Transactions can be business to business or business to consumer. Assessment focus on increase of deliveries to households in the city.	WSP Scenario Planning Toolbox	X
Electric Mobility	Vehicles that operate by electric propulsion. Includes a number of different forms, including hybrid electric vehicles (HEVs), Plug-in Hybrid Electric Vehicles (PHEV), and Battery Electric Vehicles (BEVs). Assessment focus on emissions regulation scope and noise.	WSP Scenario Planning Toolbox	X
Shared Mobility	Covers a combination of mobility options anchored on the concept of shared services and access to vehicles. Includes car sharing, ridesharing, and shared rides on on-demand mobility services. Assessment focus on decoupling of vehicle ownership and travelling, and drop-off/pick-up instead of parking.	WSP Scenario Planning Toolbox	X

Trend	Description	Source	Selected
Sharing Economy	Describes economic activity based around the concept of shared access to assets and services rather than ownership	WSP Scenario Planning Toolbox	
Autonomous and Connected Vehicles	Vehicle systems capable of intelligently navigating and responding to complex environments with little to no human input; and vehicles capable of communicating and interacting over wireless networks with other vehicles, infrastructure, people, and the cloud. Assessment focus on new enforcement of regulations, changed parking needs, drop-off/pick-up instead of parking, and the risk of excessive empty-driving.	WSP Scenario Planning Toolbox	X
Ride-hailing	Ride-hailing is a type of on-demand mobility service offered by transportation network companies, which match paying riders to rides typically provided by private vehicle owners. Assessment focus on similarities to transit and drop-off/pick-up instead of parking.	WSP Scenario Planning Toolbox	X
Climate Change	Change in average temperatures across the globe is resulting in a shift in regional climates and increase frequency of extreme weather events. Assessment focus on weather-related changes in travel demand.	WSP Scenario Planning Toolbox	X
Natural Disasters (floods, droughts, earthquakes, wildfires)	For reasons including climate change and geographic location, there have been an increase in extreme weather events and natural disasters.	WSP Scenario Planning Toolbox	
Aging Population	Longer life expectancy and declining birth rates have resulted in an expanding proportion of elderly population. Assessment focus on changed accessibility needs and increased home-based services.	WSP Scenario Planning Toolbox	X
Foreign Investment in Real Estate	Foreign investment in the real estate market has put pressure on housing demand. Despite current policies, housing prices remain high.	WSP Scenario Planning Toolbox	
Work Anywhere Culture	Ability for some/many employees to work remotely instead of having to go to an office daily. Assessment focus on less reliable/recurring travel patterns.	WSP Scenario Planning Toolbox	X
Urbanisation	A global shift in populations from rural to urban. At a regional scale, this has and continues to manifest in the form of a growing emphasis on cities. Globally, this is resulting in the growth of cities in developing countries	WSP Scenario Planning Toolbox	
Shifting Global Dynamics	Development in emerging economies is changing global dynamics. Cities in other parts of the world are becoming more competitive, changing the dynamics between major global powers.	WSP Scenario Planning Toolbox	

Trend	Description	Source	Selected
Demo-graphic Attitudes (Lifestyle, consumer trends, mobility)	Changing attitudes for individuals changes the frequency and type of goods demanded and space preferences, while new trends in mobility and accessibility change people's (un)willingness to travel certain distances by certain modes.	WSP Scenario Planning Toolbox	
Internet of Things (IOT)	Interconnectivity between computing systems, physical objects, and places, allowing for data to be sent and received over a digital network. Assessment focus on new types of enforcement and facilitation of UVARs.	WSP Scenario Planning Toolbox	X
Advanced Building Construction Technology	Emerging trends such as automation, advanced robotics, computer aided manufacturing, 3D printing, and new construction materials have the potential to change the way construction is conducted, and ultimately impact speed of construction and costs.	WSP Scenario Planning Toolbox	
Shifting Political Climate	Changes to political climates could mean different priorities in policy and funding	WSP Scenario Planning Toolbox	
Disease and Invasive Species	The presence of disease and invasive species could impact the desirability of the region. Possibly linked to climate change.	WSP Scenario Planning Toolbox	
Agricultural Productivity and Food Security	Consumption of resources is increasing as populations increase, and mixed with climate change could lead to problems of food security. Population growth and urbanization also encroach on lands dedicated to agricultural.	WSP Scenario Planning Toolbox	
Global Outsourcing/ Re-shoring	Outsourcing certain business processes to other countries where the desired tasks can be completed at a less expensive rate. Next wave of shifts (outsourcing of knowledge sector jobs, reshoring of industry)	WSP Scenario Planning Toolbox	
Energy Transition	Combination of forces motivating a transition of energy sources towards renewables and low emission sources. Pricing from policies that come from upper levels of government, changes to the cost of production and supply, as well as changes in demand from across the market (including in the US) could have major impacts to increases or decreases in prices of energy.	WSP Scenario Planning Toolbox	
Lower travel demand	Various reasons, such as unemployment, smaller population, poverty, working from home, etc. reduce the demand for travel and transport. Assessment focus on the efficiency of UVARs and income effects of pricing measures.	Future-proofing workshop	X
Higher travel demand	Population growth, urbanisation, cheaper travelling and/or increased economic activity and wealth increase the demand for travel and transport. Assessment focus on the need for UVARs and pricing levels.	Future-proofing workshop	X

Each building block was discussed in the light of each selected trend. Insights (positive or negative) where noted and codes where added:

- Green: The building block is either unaffected by the trend or judged to be even more effective/justified than today.
- Yellow: The building block is still effective and relevant, but adjustments or considerations may be needed.
- Red: There is a risk that the trend could decrease the building block's effectiveness or utility.

Some trends could have a large impact on the need for and effectiveness of UVARs, but this impact will not differ between building blocks. For example, a development in society that would lead to a massive increase in car traffic, would increase the need for (any types of) UVARs. Obvious effects of climate change in a city will increase the general urgency to decrease emissions, which will strengthen the acceptance for (any types of) UVARs, etc. Because this reasoning is general and does not depend on the specific building block, those general impacts of some trends have not been described in the assessment. The focus has instead been on aspects that are affecting building blocks differently.

The resulting table is referred to as the assessment matrix.

Mapping of Pilot Cities' Building Blocks

To gather information on which building blocks that are included in each pilot city's UVAR strategy, a spreadsheet was developed where the building blocks are listed and the user can tick the building blocks that are relevant for their city. The user also marks if the building block is already existing, planned (as part of ReVeAL or otherwise) and/or considered (several options can be selected). The user is asked to add information on year of introduction, the geographical scope and add free-text comments. The spreadsheet also allows to create a summary of all the information the user provided.

During April and May, all pilot cities filled out the spreadsheet. This was made by the pilot city coordinators and/or pilot city representatives.

Generation of Pilot City Resiliency Reports

Based on the assessment matrix and the pilot cities' building block summaries, pilot city-specific assessments are made.

The resiliency of each pilot city's strategy will obviously depend on many other factors than the general assessment from the assessment matrix, such as climate, geographic and demographic factors as well as the status of the city concerning governance, technology, and more. However, at the point of this milestone (month 12) these circumstances have not been covered enough and described by the ReVeAL project, for it to be included in the initial assessment. These will be described in WP1 (ReVeAL Transition Framework and Change Management) and will be considered in the final assessment.

Results

Below the results of each of the three steps of the assessment process are described.

General Resiliency Assessment of UVAR Measures

Starting on the next page, the assessment matrix has been inserted.

Table 2: The assessment matrix

	Current trends and future technologies												
Building block	Future pandemic	The Gig Economy	E-Commerce	Electric Mobility	Shared Mobility	Autonomous and Connected Vehicles	Ride-hailing	Climate Change and Natural Disasters	Aging Population	Work Anywhere Culture	Internet of Things (IOT)	Lower travel demand	Higher travel demand
Spatial interventions - School street - Car-free school area				Silent cars may increase the need for this (safety)		Automation will enable new enforcement of this							Higher travel demand could increase need for this
Spatial interventions - School street - K&R						Automation will enable new enforcement of this							Higher travel demand could increase need for this
Spatial interventions - School street - Speed regulated						Automation will enable new enforcement of this							Higher travel demand could increase need for this
Spatial interventions - Cycling street -	Could enable distancing with active modes		Regulation may need to be adapted to deliveries		If micro-mobility is a big part of the shared mob., it might increase the need for this	Automation will enable/need new enforcement of this		Changing weather can affect cycling levels	Make sure infrastructure is suitable for other ability-giving vehicles as well				
Spatial interventions - Traffic filter - Road block	Road block could hinder emergency transports					Automation will enable new enforcement of this						Lower travel demand could reduce its impact	Higher travel demand could increase need for this
Spatial interventions - Traffic filter - Capacity restraint - limiting volume or type of vehicle			Regulation may need to be adapted to deliveries		Possible exemptions for high-occupancy shared vehicles	Automation will enable/need new enforcement of this						Lower travel demand could reduce its impact	Higher travel demand could increase need for this
Spatial interventions - Traffic filter - Visual Barrier			Regulation may need to be adapted to deliveries			Less need for this with automation						Lower travel demand could reduce its impact	Higher travel demand could increase need for this
Spatial interventions - Traffic filter - Through traffic ban			Regulation may need to be adapted to deliveries			Automation will enable/need new enforcement of this						Lower travel demand could reduce its impact	Higher travel demand could increase need for this
Spatial interventions - Traffic filter - One-way street						Automation will enable/need new enforcement of this						Lower travel demand could reduce its impact	Higher travel demand could increase need for this
Spatial interventions - Removing parking or road space - Parklet			Could hinder efficient deliveries				Could hinder pick up / drop off						Higher travel demand could increase need for this

	Current trends and future technologies												
Building block	Future pandemic	The Gig Economy	E-Commerce	Electric Mobility	Shared Mobility	Autonomous and Connected Vehicles	Ride-hailing	Climate Change and Natural Disasters	Aging Population	Work Anywhere Culture	Internet of Things (IOT)	Lower travel demand	Higher travel demand
Spatial interventions - Removing parking or road space - Widen pavement	Could enable distancing with active modes		Could hinder efficient deliveries				Could hinder pick up / drop off		Ability-giving vehicles/equip-ment could increase the need for this				Higher travel demand could increase need for this
Spatial interventions - Removing parking or road space - Drop-off zone shared mobility	Avoidance of shared mobility				Shared mobility could increase need for this	Automation could increase need for this	RH may increase the need for this		An aging population may increase the need for this				Higher travel demand could increase need for this
Spatial interventions - Removing parking or road space - Logistics bay (mini-hub)			Will probably be needed for e-commerce										
Spatial interventions - Cycle lane - Redistribution of road space	Could enable distancing with active modes				If micro-mobility is a big part of the shared mob., it might increase the need for this			Changing weather can affect cycling levels	Make sure infrastructure is suitable for other ability-giving vehicles as well	Could lead to higher demand for short distance/local traffic			Higher travel demand could increase need for this
Spatial interventions - Cycle lane - Conversion of parking lane	Could enable distancing with active modes		Could hinder efficient deliveries		If micro-mobility is a big part of the shared mob., it might increase the need for this			Changing weather can affect cycling levels	Make sure infrastructure is suitable for other ability-giving vehicles as well				Higher travel demand could increase need for this
Spatial interventions - Pedestrian street - Mixed used cycling-pedestrians	Could enable distancing with active modes		Could hinder efficient deliveries			Automation will enable new enforcement of this		Changing weather can affect cycling levels	Make sure infrastructure is suitable for other ability-giving vehicles as well				
Spatial interventions - Pedestrian street - Residents only vs other groups	Could enable distancing with active modes		Regulation may need to be adapted to deliveries			Automation will enable new enforcement of this		Changing weather can affect cycling levels	Make sure infrastructure is suitable for other ability-giving vehicles as well				
Spatial interventions - Pedestrian street - Temporal pedestrian street	Could enable distancing with active modes	Gig economy may make peak times less reliable	Could hinder efficient deliveries			Automation will enable new enforcement of this		Changing weather can affect cycling levels	Make sure infrastructure is suitable for other ability-giving vehicles as well				
Spatial interventions - Bus/tram priority lane -	Avoidance of shared mobility		Could hinder efficient deliveries		Regulation may need to be adapted to shared mobility	Automation will enable new enforcement of this	Consider if RH vehicles should be included in priority					Possible lower occupancy on public transport	Possible higher need for bus/tram priority lane
Spatial interventions - Zone de rencontre/Begegnungszone/woonerven -	Could enable distancing with active modes		Could hinder efficient deliveries			Automation will enable new enforcement of this							Higher travel demand could increase need for this

	Current trends and future technologies												
Building block	Future pandemic	The Gig Economy	E-Commerce	Electric Mobility	Shared Mobility	Autonomous and Connected Vehicles	Ride-hailing	Climate Change and Natural Disasters	Aging Population	Work Anywhere Culture	Internet of Things (IOT)	Lower travel demand	Higher travel demand
Pricing measures - Congestion charge - Applied to a perimeter or an area	May be hinder to safe transport of critical staff	Problem if designed for peak times			With shared mobility, regulation and/or enforcement needs to be adapted		RH may increase the need for this				IoT will enable new enforcement of this	Lower travel demand may decrease income level of city	Higher travel demand may need adjustment of fees
Pricing measures - Congestion charge - Applied to specific points	May be hinder to safe transport of critical staff	Problem if designed for peak times			With shared mobility, regulation and/or enforcement needs to be adapted		RH may increase the need for this				IoT will enable new enforcement of this	Lower travel demand may decrease income level of city	Higher travel demand may need adjustment of fees
Pricing measures - Congestion charge - Distance-based charge	May be hinder to safe transport of critical staff	Problem if designed for peak times			With shared mobility, regulation and/or enforcement needs to be adapted		RH may increase the need for this				IoT will enable new enforcement of this	Lower travel demand may decrease income level of city	Higher travel demand may need adjustment of fees
Pricing measures - Pollution charge - Applied to a perimeter or an area	May be hinder to safe transport of critical staff	Problem if designed for peak times		Electrification will reduce its impact	With shared mobility, regulation and/or enforcement needs to be adapted		RH may increase the need for this				IoT will enable new enforcement of this	Lower travel demand may decrease income level of city	Higher travel demand may need adjustment of fees
Pricing measures - Parking charge - Dynamic price (real time)	May be hinder to safe transport of critical staff	Problem if designed for peak times			With shared mobility, regulation and/or enforcement needs to be adapted	Automation could reduce its impact	RH may increase the need for this		Adapt charge for personal accessibility level		IoT will enable new enforcement of this	Lower travel demand may decrease income level of city	Higher travel demand may need adjustment of fees
Pricing measures - Parking charge - Fixed price	May be hinder to safe transport of critical staff	Problem if designed for peak times	Possibly exclude delivery vehicles from charge?		With shared mobility, regulation and/or enforcement needs to be adapted	Automation could reduce its impact			Adapt charge for personal accessibility level		IoT will enable new enforcement of this	Lower travel demand may decrease income level of city	Higher travel demand may need adjustment of fees
Pricing measures - Parking charge - From on-street to off-street parking	May be hinder to safe transport of critical staff	Problem if designed for peak times	Could hinder efficient deliveries		With shared mobility, regulation and/or enforcement needs to be adapted	Automation could reduce its impact			Adapt charge for personal accessibility level		IoT will enable new enforcement of this	Lower travel demand may decrease income level of city	Higher travel demand may need adjustment of fees

	Current trends and future technologies												
Building block	Future pandemic	The Gig Economy	E-Commerce	Electric Mobility	Shared Mobility	Autonomous and Connected Vehicles	Ride-hailing	Climate Change and Natural Disasters	Aging Population	Work Anywhere Culture	Internet of Things (IOT)	Lower travel demand	Higher travel demand
Pricing measures - Traffic flow management - Time-based charge	May be hinder to safe transport of critical staff	Problem if designed for peak times			With shared mobility, regulation and/or enforcement needs to be adapted	Risk of increased traffic from empty driving if leaving the zone	RH may increase the need for this			This may make peak times less reliable but also less extreme	IoT will enable new enforcement of this	Lower travel demand may decrease income level of city	Higher travel demand may need adjustment of fees
Pricing measures - Traffic flow management - Distance-based charge	May be hinder to safe transport of critical staff	Problem if designed for peak times			With shared mobility, regulation and/or enforcement needs to be adapted		RH may increase the need for this				IoT will enable new enforcement of this	Lower travel demand may decrease income level of city	Higher travel demand may need adjustment of fees
Pricing measures - Urban logistic charge - Mobility credits	May be hinder to safe deliveries to risk groups		E-commerce could increase need for this						Could hinder service for elderly	This may make peak times less reliable but also less extreme	IoT will enable new enforcement of this		Higher travel demand may need adjustment of fees
PZEZ/LTZ - Regulation by emissions -	May be hinder to safe transport of critical staff or safe deliveries		Could have impact on delivery vehicle fleet	Electrification will reduce its impact (but also make it more possible)	With shared mobility, enforcement needs to be adapted	Automation will enable/need new enforcement of this	RH may increase the need for this				IoT will enable new enforcement of this	Lower travel demand may make measure less efficient	Higher travel demand could increase need for this
PZEZ/LTZ - Regulation by vehicle type and/or dimensions	May be hinder to safe transport of critical staff or safe deliveries		Could have impact on delivery vehicle fleet		With shared mobility, enforcement needs to be adapted	Automation will enable/need new enforcement of this	RH may increase the need for this				IoT will enable new enforcement of this		Higher travel demand could increase need for this
PZEZ/LTZ – Regulation by trip type			Regulation may need to be adapted to deliveries		With shared mobility, enforcement needs to be adapted	Automation will enable/need new enforcement of this	Regulation may need to be adapted to RH				IoT will enable new enforcement of this		Higher travel demand could increase need for this
PZEZ/LTZ - Scheme timescale – Programmed Time window (e.g. night time/ time of day/week/year/season)		Gig economy may make peak times less reliable	Regulation may need to be adapted to deliveries		With shared mobility, enforcement needs to be adapted	Automation will enable/need new enforcement of this	Regulation may need to be adapted to RH		Could hinder service for elderly	This may make peak times less reliable but also less extreme	IoT will enable new enforcement of this		Higher travel demand could increase need for this
PZEZ/LTZ - Scheme timescale – Reactive Operation (e.g. by pollution /congestion(/pandemic ….))			Regulation may need to be adapted to deliveries		With shared mobility, enforcement needs to be adapted	Automation will enable/need new enforcement of this	Regulation may need to be adapted to RH		Could hinder service for elderly		IoT will enable new enforcement of this		Higher travel demand could increase need for this
PZEZ/LTZ - Scheme timescale - Phasing: E.g. introductory warning letters, tightening standards, ...					With shared mobility, enforcement needs to be adapted	Automation will enable/need new enforcement of this	Regulation may need to be adapted to RH				IoT will enable new enforcement of this		Higher travel demand could increase need for this

	Current trends and future technologies												
Building block	Future pandemic	The Gig Economy	E-Commerce	Electric Mobility	Shared Mobility	Autonomous and Connected Vehicles	Ride-hailing	Climate Change and Natural Disasters	Aging Population	Work Anywhere Culture	Internet of Things (IOT)	Lower travel demand	Higher travel demand
PZEZ/LTZ - Regulation by permit - Permit to travel			May increase the demand for permits/ the number of permits		Regulation may need to be adapted to shared mobility		Regulation may need to be adapted to RH				IoT will enable new enforcement of this		Higher travel demand could increase need for this
PZEZ/LTZ - Regulation by permit - Vehicle ownership permit					Regulation may need to be adapted to shared mobility		Regulation may need to be adapted to RH				IoT will enable new enforcement of this		Higher travel demand could increase need for this
PZEZ/LTZ - Regulation by permit - Permit to park (e.g. residents/business)					Regulation may need to be adapted to shared mobility	Automation could reduce its impact					IoT will enable new enforcement of this		Higher travel demand could increase need for this
PZEZ/LTZ - Regulation by permit - Permit to build car parking space					Regulation may need to be adapted to shared mobility						IoT will enable new enforcement of this		Higher travel demand could increase need for this
ZEZ – Regulation by other	May be hinder to safe transport of critical staff or safe deliveries	Problem if designed for peak times	Regulation may need to be adapted to deliveries		Regulation may need to be adapted to shared mobility		Regulation may need to be adapted to RH		Could hinder service for elderly		IoT will enable new enforcement of this		Higher travel demand could increase need for this
Future options - enabler - Geofencing - Enabler for fuel restrictions	May be hinder to safe transport of critical staff or safe deliveries			Electrification will reduce its impact		This requires connection and in some cases automation					This will be facilitated by IoT		Higher travel demand could increase need for this
Future options - Geofencing - Enabler for access restrictions	May be hinder to safe transport of critical staff or safe deliveries					This requires connection and in some cases automation			Could hinder service for elderly		This will be facilitated by IoT		Higher travel demand could increase need for this
Future options - Geofencing - Enabler for speed restrictions						This requires connection and in some cases automation					This will be facilitated by IoT	Lower travel demand could increase need for this	Higher travel demand may make measure less efficient
Future options - Geofencing - Other	May be hinder to safe transport of critical staff or safe deliveries					This requires connection and in some cases automation					This will be facilitated by IoT		
Future options - Connected vehicles and infrastructure -											This will be facilitated by IoT		
Future options - Autonomous vehicles -						This requires automation							
Future options - Digital twins/data sharing platforms/standards/systems -											This will be facilitated by IoT		

	Current trends and future technologies												
Building block	Future pandemic	The Gig Economy	E-Commerce	Electric Mobility	Shared Mobility	Autonomous and Connected Vehicles	Ride-hailing	Climate Change and Natural Disasters	Aging Population	Work Anywhere Culture	Internet of Things (IOT)	Lower travel demand	Higher travel demand
Future options - Dynamic traffic signalling/management/ITS/rerouting -		Gig economy may increase need for this				Automation will enable/need new enforcement of this	RH may increase the need for this				IoT will enable new enforcement of this		Higher travel demand could increase need for this
Future options - Dynamic Space Management - Kerb side management	May be hinder to safe transport of critical staff or safe deliveries	Gig economy may increase need for this	E-commerce could increase need for this			Automation may increase need for this	RH may increase the need for this		Adapt for service to elderly		IoT will enable new enforcement of this		Higher travel demand could increase need for this
Future options - Dynamic Space Management - Parking management	May be hinder to safe transport of critical staff or safe deliveries	Gig economy may increase need for this	E-commerce could increase need for this			The non-need for parking of fully autonomous vehicles could limit the effect of this			Adapt for personal accessibility level		IoT will enable new enforcement of this		Higher travel demand could increase need for this
Future options - Sharing/mobility hub/MaaS/rented micro-mobility/… - MaaS system	Avoidance of shared mobility				Shared mobility could could contribute to this		Ride hailing could contribute to this				This will be facilitated by IoT		Higher travel demand could increase need for this
Future options - Sharing/mobility hub/MaaS/rented micro-mobility/… - Mobility hub	Avoidance of shared mobility				Shared mobility could could contribute to this								Higher travel demand could increase need for this
Future options - Sharing/mobility hub/MaaS/rented micro-mobility/… - Easy access micro-mob renting	Avoidance of shared mobility				Shared mobility could could contribute to this						This will be facilitated by IoT		Higher travel demand could increase need for this
Future options - Sharing/mobility hub/MaaS/rented micro-mobility/… - Transit, waterways, freight consolidation centre…	Avoidance of shared mobility										This will be facilitated by IoT		
Future options - High-occupancy vehicles - Policy to reduce single-occupancy	May be hinder to safe transport of critical staff or safe deliveries		Regulation may need to be adapted to deliveries		Shared mobility could could contribute to this	Automation will enable/need new enforcement of this	RH may increase the need for this				This will be facilitated by IoT		Higher travel demand could increase need for this
Other - Increased mobility options	Avoidance of shared mobility				Shared mobility could could contribute to this								Higher travel demand could increase need for this
Other - Permit/exemption charge													
Other - Roads on which vehicles are not allowed to stop			Regulation may need to be adapted to deliveries			Automation will enable/need new enforcement of this	Regulation may need to be adapted to RH						

	Current trends and future technologies												
Building block	Future pandemic	The Gig Economy	E-Commerce	Electric Mobility	Shared Mobility	Autonomous and Connected Vehicles	Ride-hailing	Climate Change and Natural Disasters	Aging Population	Work Anywhere Culture	Internet of Things (IOT)	Lower travel demand	Higher travel demand
Other - Lorry control						Automation will enable/need new enforcement of this					This will be facilitated by IoT		
Other - Pricing measures - Economic incentives for fleet renewal				Electrification will reduce its impact									Higher travel demand could increase need for this
Other - Pricing measures - Economic incentives for mobility services	Avoidance of shared mobility				Shared mobility could could contribute to this								Higher travel demand could increase need for this
Other - (Semi-)automated shuttle service	Avoidance of shared mobility					This requires automation							

The Pilot Cities' Regulatory and Policy Measures

In the table below, all building blocks have been listed and the pilot cities' use of them has been marked. A description of each building block can be found in the appendix. Except for the summarised information in this table, the cities also provided information on whether the measures are planned in ReVeAL or otherwise, the geographical scope as well as further descriptions. This information has not been included here, for readability reasons.

Table 3: Building blocks in each pilot city

	Pilot city UVAR strategy					
Building block	**Bielefeld**	**Helmond**	**Jerusalem**	**London**	**Padua**	**Vitoria-Gasteiz**
Spatial interventions - School street - Car-free school area			Planned 2019		Planned 2021	Considered
Spatial interventions - School street - K&R					Planned 2021	Considered
Spatial interventions - School street - Speed regulated	Existing			Existing	Existing + planned 2022	Existing
Spatial interventions - Cycling street -	Existing + considered	Existing + considered	Planned 2022	Existing	Planned 2025	
Spatial interventions - Traffic filter - Road block	Existing	Considered	Existing	Existing + planned		Planned 2020
Spatial interventions - Traffic filter - Capacity restraint - limiting volume or type of vehicle	Planned	Planned				Planned 2020
Spatial interventions - Traffic filter - Visual Barrier	Considered	Planned	Existing	Existing		Planned 2020
Spatial interventions - Traffic filter - Through traffic ban		Planned	Existing	Existing + planned	Planned 2030	Existing
Spatial interventions - Traffic filter - One-way street	Existing	Existing	Existing	Existing	Existing	Existing

	Pilot city UVAR strategy					
Building block	**Bielefeld**	**Helmond**	**Jerusalem**	**London**	**Padua**	**Vitoria-Gasteiz**
Spatial interventions - Removing parking or road space - Parklet	Considered			Existing + planned		Existing
Spatial interventions - Removing parking or road space - Widen pavement	Considered			Existing	Existing	Existing
Spatial interventions - Removing parking or road space - Drop-off zone shared mobility		Considered		Existing	Planned 2025	Considered
Spatial interventions - Removing parking or road space - Logistics bay (mini-hub)		Considered				
Spatial interventions - Cycle lane - Redistribution of road space	Considered		Existing	Existing	Existing + planned 2022	Existing
Spatial interventions - Cycle lane - Conversion of parking lane				Existing	Existing	Existing
Spatial interventions - Pedestrian street - Mixed used cycling-pedestrians	Existing	Planned	Existing	Existing + planned	Existing	Existing
Spatial interventions - Pedestrian street - Residents only vs other groups		Planned	Existing		Existing	Existing
Spatial interventions - Pedestrian street - Temporal pedestrian street						
Spatial interventions - Bus/tram priority lane -	Existing + planned		Existing + planned	Existing	Existing + planned 2025	Existing
Spatial interventions - Zone de rencontre/Begegnungszone/woonerven -		Existing				Planned 2020

	Pilot city UVAR strategy					
Building block	**Bielefeld**	**Helmond**	**Jerusalem**	**London**	**Padua**	**Vitoria-Gasteiz**
Pricing measures - Congestion charge - Applied to a perimeter or an area				Existing		
Pricing measures - Congestion charge - Applied to specific points						
Pricing measures - Congestion charge - Distance-based charge						
Pricing measures - Pollution charge - Applied to a perimeter or an area			Existing + planned 2020	Existing		
Pricing measures - Parking charge - Dynamic price (real time)					Planned 2025	
Pricing measures - Parking charge - Fixed price				Existing	Existing	Existing
Pricing measures - Parking charge - From on-street to off-street parking					Planned 2022	Existing
Pricing measures - Traffic flow management - Time-based charge						
Pricing measures - Traffic flow management - Distance-based charge						
Pricing measures - Urban logistic charge - Mobility credits						
PZEZ/LTZ - Regulation by emissions -		Planned	Existing + planned	Existing + planned	Planned 2022	
PZEZ/LTZ - Regulation by vehicle type and/or dimensions			Planned 2020	Existing + planned	Considered	

	Pilot city UVAR strategy					
Building block	**Bielefeld**	**Helmond**	**Jerusalem**	**London**	**Padua**	**Vitoria-Gasteiz**
PZEZ/LTZ – Regulation by trip type	Considered	Planned		Existing + planned	Existing + planned 2021	Existing
PZEZ/LTZ - Scheme timescale – Programmed Time window (e.g. night time/ time of day/week/year/season)					Existing	Existing
PZEZ/LTZ - Scheme timescale – Reactive Operation (e.g. by pollution /congestion(/pandemic ….))					Existing	
PZEZ/LTZ - Scheme timescale - Phasing: E.g. introductory warning letters, tightening standards, ...			Planned 2020	Existing	Planned 2021	Existing
PZEZ/LTZ - Regulation by permit - Permit to travel	Considered	Planned		Existing	Planned 2021	Existing
PZEZ/LTZ - Regulation by permit - Vehicle ownership permit						
PZEZ/LTZ - Regulation by permit - Permit to park (eg residents/business)				Existing	Considered	
PZEZ/LTZ - Regulation by permit - Permit to build car parking space					Considered	
PZEZ/LTZ – Regulation by other				Existing	Considered	Existing + planned
Future options - enabler - Geofencing - Enabler for fuel restrictions				Considered		
Future options - Geofencing - Enabler for access restrictions		Considered	Planned			

	Pilot city UVAR strategy					
Building block	**Bielefeld**	**Helmond**	**Jerusalem**	**London**	**Padua**	**Vitoria-Gasteiz**
Future options - Geofencing - Enabler for speed restrictions		Considered				
Future options - Geofencing - Other			Planned 2020			
Future options - Connected vehicles and infrastructure -			Considered			
Future options - Autonomous vehicles -			Considered		Planned 2025	
Future options - Digital twins/data sharing platforms/standards/systems -					Considered	
Future options - Dynamic traffic signalling/management/ITS/rerouting -		Considered	Existing	Existing	Planned 2025	
Future options - Dynamic Space Management - Kerb side management			Existing			
Future options - Dynamic Space Management - Parking management						
Future options - Sharing/mobility hub/MaaS/rented micro-mobility/… - MaaS system			Considered		Planned 2025	
Future options - Sharing/mobility hub/MaaS/rented micro-mobility/… - Mobility hub	Planned				Planned 2025	
Future options - Sharing/mobility hub/MaaS/rented micro-mobility/… - Easy access micro-mob renting				Existing	Planned 2022	

	Pilot city UVAR strategy					
Building block	**Bielefeld**	**Helmond**	**Jerusalem**	**London**	**Padua**	**Vitoria-Gasteiz**
Future options - Sharing/mobility hub/MaaS/rented micro-mobility/… - Transit, waterways, freight consolidation centre…				Planned	Planned 2022	Considered 2021
Future options - High-occupancy vehicles - Policy to reduce single-occupancy			Existing			
Other - Increased mobility options				Existing	Existing + planned	
Other - Permit/exemption charge				Existing	Existing + planned	
Other - Roads on which vehicles are not allowed to stop				Existing		
Other - Lorry control				Existing		
Pricing measures - Economic incentives for fleet renewal				Existing		
Pricing measures - Economic incentives for mobility services				Existing		
(Semi-)automated shuttle service		Considered				
Traffic Flow Improvement			Existing			

Resiliency Assessment for Each Pilot City

Here, the results for each pilot city's UVAR strategy is summarised. For detailed descriptions, please refer to the assessment matrix. As mentioned above, the results are on a general level and any city-specific strategies to handle or prepare for the different trends have not been considered.

For each trend, the impacts and possible needs for adjustments or considerations is discussed *in case that trend turns out*, for example "in a future with extensive e-commerce" or "in case shared

mobility accounts for a large share of all transport in favour of privately owned vehicles". In other words, relatively extreme outcomes compared to the status quo.

Bielefeld

The city of Bielefeld has, plans or considered 11 types of spatial interventions, two pathways to zero-emission or low-traffic zones, and a mobility hub.

Future pandemic: spatial interventions that increase space for walking and cycling are positive since they could enable better physical distancing with active modes of travel. This includes the considered measures to redistribute road or parking space to wider pavements and cycle lanes, as well as existing pedestrian/cycling streets. However, for shared transport measures such as bus/tram priority lanes and the mobility hub, the resilience is lower for a future pandemic. Permanent road blocks may also be hindering emergency/crucial transports in a pandemic (or other disasters).

E-commerce: several of Bielefeld's measures would need to be adapted to enable efficient deliveries to households in a possible future where e-commerce makes up a large share of all consumption of goods and services. Regulating the delivery transports in the city centre would need to be balanced with the ability for stakeholders to carry out the deliveries that are needed in an efficient way. It should be carefully considered if and how the spatial intervention measures and the PZEZ/LTZ should apply to delivery vehicles. Permanent removal/transition of road side space may need to be accompanied by other solutions for delivery of parcels. With a permit-based system, a boom in e-commerce may lead to an increased number of permits needed.

Shared mobility: If vehicles are shared to a higher extent in the future, there may also be a need to adapt some of the regulations. For example, are shared vehicles to be considered as a form of public transport and thus be allowed to use the bus/tram priority lanes? The same goes for the PZEZ/LTZ measures – should shared vehicles enjoy benefits that private vehicles are not? This will also depend on what forms the sharing takes. For example, if it mainly regards micro-mobility such as bikes and scooters, this trend will instead affect cycle lanes and other spatial interventions.

Autonomous and connected vehicles: The introduction of autonomous and connected vehicles will have large effects on many UVARs. Regulation of speed and other aspects can be enforced in new ways when the vehicles are controlled by software and not drivers. Measures such as visual barriers may be less motivated because all regulations will be processed through the vehicle itself instead of through the mind of the driver.

Ride-hailing: will need efficient pick-ups and drop-offs of passengers. This should be considered when removing parking or road space, so that ride-hailing trips to those areas are not disturbing the environment or other traffic. Also, as for shared transport, there are options on how to handle ride-hailing transports when it comes to bus/tram priority lanes as well as PZEZ/LTZ measures.

Climate change: Measures aimed at increasing cycling or depending on large cycling shares in the modal split could be regarded. Some places will be hotter in the future, others will experience longer winters, both things could lower the demand for cycling. On the other hand, climate change could also affect the weather to allow for cycling a larger share of the year. Each city should

monitor this development and analyse any changes in the conditions for cyclists and other users of micro-mobility.

Aging population: Measures aimed at cycling and walking should also be adapted to make room for other ability-giving vehicles, for which the need may increase in the future. This trend may also further increase the need for wider pavements, which Bielefeld is considering.

Internet of Things: PZEZ/LTZ measures could be enforced in new ways with the expansion of Internet of Things. With vehicles and infrastructure being connected to a high extent, regulations by trip type and permits to travel could be implemented cheaper and more efficient than today, and investments in enforcement systems made today should consider this.

Lower travel demand: for spatial interventions aimed at slowing or re-directing traffic (road blocks etc.), the impact will be reduced with lower traffic levels. It may also be harder to justify bus/tram priority lanes with lower ridership numbers and with less congestion those priority lanes would not be needed to the same extent.

Higher travel demand: would increase the need and efficiency of most building blocks.

Helmond

The city of Helmond has, plans or considered 11 types of spatial interventions, plans three pathways to zero-emission or low-traffic zones, and considers four future options.

Future pandemic: With the need of physical distancing, spatial interventions that increase space for walking and cycling are positive since they encourage active modes of travel. This includes the pedestrian/cycling streets and mixed-use space. Measures aiming at increasing shared/public transport measures such as drop-off zones for shared mobility and semi-automated shuttle service, have a lower resilience in this situation. Permanent road blocks may also be hindering emergency/crucial transports in a pandemic (or in other disasters), and non-dynamic access restrictions through geofencing or by emission standards could hinder safe travel for critical staff or safe deliveries in a situation where it may be important to be able to travel in a personal vehicle.

E-commerce: If e-commerce would increase dramatically, several of Helmond's measures would need to be adapted to enable efficient deliveries to households. Controlling the amount of transports in the city would need to be balanced with the ability to carry out the deliveries that are needed in an efficient way. It could be considered if and how the spatial intervention measures and the PZEZ/LTZ should apply to delivery vehicles. Permanent removal/transition of road side space may need to be accompanied by other solutions for delivery of parcels. On the other hand, Helmond also considers logistics bays/mini-hubs, which would probably be needed in a future with extensive e-commerce. The PZEZ/LTZ regulation for emissions could possibly have a large impact on the vehicle fleet used for deliveries, therefore it is crucial to design it to match the goals of the city (e.g. many small delivery vehicles or fewer large ones, etc.).

Electric Mobility: Helmond is planning a zone which is regulated by emissions. If the goal is only to reduce emissions, electrification will not cause a problem. But if the city is also expecting other positive side-effects of this measure, such as lower traffic volumes in general in the zone, rapid

electrification of the vehicle fleet will reduce the impact of the regulation. On the other hand, a large share of electric vehicles in the fleet will make the road to a ZEZ easier.

Shared mobility: If there is a trend to move from owning vehicles to share vehicles and rides to a higher extent, there may also be a need to adapt some of the regulations. For example, are shared vehicles to enjoy benefits that private vehicles are not? When it comes to enforcement of regulation by trip type and permit to travel, the permit/trip type needs to follow the traveller and not the vehicle if vehicles are shared by many. Further, the need for drop-off zones for shared mobility, which Helmond considers, may increase with this trend. But it will also depend on what forms the sharing takes. For example, if it mainly regards micro-mobility such as bikes and scooters, this trend will instead affect cycle lanes and other spatial interventions.

Autonomous and connected vehicles: regulation of speed and other aspects can be enforced in new ways when the vehicles are controlled by software and not drivers. Measures such as visual barriers may be less motivated because all regulations will be processed through the vehicle itself instead of through the mind of the driver.

Ride-hailing: A large increase of ride-hailing travel will need efficient pick-ups and drop-offs of passengers; which Helmond is considering. Also, as for shared transport, there are options on how to handle ride-hailing transports when it comes to PZEZ/LTZ measures, where regulation may need to be adapted if ride-hailing vehicles are not to be controlled by the same regulations as private vehicles (at least during the ride-haling trips, if private vehicles are used for the service). Finally, with an increasing number of ride-haling vehicles cruising the streets for passengers, there may be an increased need for an efficient traffic control/management system, which Helmond is also considering.

Climate change: Measures aimed at increasing cycling or depending on large cycling shares in the modal split should be regarded. Some places will be hotter in the future, others will experience longer winters, both things could lower the demand for cycling. On the other hand, climate change could also affect the weather to allow for cycling a larger share of the year. Each city should monitor this development and analyse any changes in the conditions for cyclists and other users of micro-mobility.

Aging population: Measures aimed at cycling and walking should also be adapted to make room for other ability-giving vehicles, for which the need may increase in the future. This trend may also further increase the need for drop-off zones, which Helmond is considering. However, if implementing access restrictions through geofencing, it must be designed carefully to not hinder service for elderly (both mobility services but also access for service staff in households and home deliveries).

Internet of Things: PZEZ/LTZ measures could be enforced in new ways with the expansion of the Internet of Things, and some of the future options require or will be facilitated by it. With vehicles and infrastructure being connected to a high extent, regulations by emissions, trip type and permits to travel could be implemented cheaper and more efficient than today, and investments in enforcement systems made today should consider this.

Lower travel demand: for spatial interventions aimed at slowing or re-directing traffic (road blocks etc.), the impact will be reduced with lower traffic levels. A zone regulated by emissions

will also have less impact with lower traffic levels. Speed regulations through geofencing may however be more justified, since lower traffic volumes increase the occurrence of speeding.

Higher travel demand: would increase the need and efficiency of most building blocks. Speed regulations may be less needed with more crowded streets.

Jerusalem

The city of Jerusalem has, plans or considered 10 types of spatial interventions, a pricing measure, four pathways to zero-emission or low-traffic zones, and considers several future options.

Future pandemic: spatial interventions that increase space for walking and cycling are positive since they could enable better physical distancing with active modes of travel. This includes the pedestrian/cycling streets and lanes. However, for measures aiming at increasing shared/public transport measures such as bus/tram priority lanes and a MaaS system, the resilience may be lower in this aspect. Permanent road blocks may also be hindering emergency/crucial transports in a pandemic (or other disasters). Pricing measures and access restrictions by emission standards or vehicle type could hinder safe travel for critical staff or safe deliveries in a situation where it may be important to be able to travel in a personal vehicle. The same goes for future options such as geofencing to enforce the same regulation, dynamic kerb side management and steering towards high occupancy of vehicles. It should be considered how these measures can be adjusted to allow for safe transports in a future pandemic.

The Gig Economy: work is typically not carried out on the same time and place every day. This could impact pricing measures if they are designed to match today's typical peak times and flexibility should be built into the system so that it can be adjusted if commuting traffic peaks start to smoothen over time. On the other hand, this trend may increase the need for dynamic measures such as dynamic traffic control and dynamic kerb side management, which are both existing in Jerusalem's UVAR strategy.

E-commerce: several of Jerusalem's measures may need to be adapted to enable efficient deliveries to households. Regulating the delivery transports in the city centre would need to be balanced with the ability for stakeholders to carry out the deliveries that are needed in an efficient way. It should be carefully considered if and how the spatial intervention measures should apply to delivery vehicles – for example, should there be a special regulation on cycling and pedestrian streets for delivery vehicles, and how should it be designed? Should delivery vehicles be allowed on the bus/tram priority line, and would they have to follow a high-occupancy policy? An increased amount of deliveries may increase the need for dynamic kerb side management so that quick delivery of parcels can be made smoothly without disturbing other traffic. The PZEZ/LTZ regulations for vehicle type/dimensions and emissions could possibly have a large impact on the vehicle fleet used for deliveries, therefore it is crucial to design it to match the goals of the city (e.g. many small delivery vehicles or fewer large ones, etc.).

Electric mobility: Jerusalem is planning a zone which is regulated by emissions as well as a pollution charge. If the goal is only to reduce emissions, the general trend of electrification of the vehicle fleet will not cause a problem. But if the city is also expecting other positive side-effects of this measure, such as lower traffic volumes in general in the zone, a rapid electrification of the vehicle fleet would reduce the impact of these regulations. On the other hand, a large share of

electric vehicles in the fleet will make the road to a ZEZ easier. The car-free school area may be even more justified with electric vehicles, because silent cars can risk the safety of children who do not hear the cars coming.

Shared mobility: there may be a need to adapt some of the regulations. For example, are shared vehicles to enjoy benefits that private vehicles are not, for example using the bus/tram priority lanes? When it comes to regulation and enforcement of the pricing and PZEZ/LTZ measures, it may need to be adapted to shared vehicles so that the pricing structure is clear (since vehicle owner and passengers will often not be the same person or household, passengers sharing the same vehicle may not know each other, etc.).

Autonomous and connected vehicles: Regulation of speed and other aspects can be enforced in new ways when the vehicles are controlled by software and not drivers. Measures such as visual barriers may be less motivated because all regulations will be processed through the vehicle itself instead of through the mind of the driver. Some of the future options that Jerusalem is considering will require automation to some degree (geofencing). In a future with self-driving cars, the need for a dynamic kerb side management system may be more obvious.

Ride-hailing: A large increase of ride-hailing travel will need efficient pick-ups and drop-offs of passengers, which could be aided by a dynamic kerb side management system. Also, as for shared transport, there are options on how to handle ride-hailing transports when it comes to bus/tram priority lanes and PZEZ/LTZ scheme timescale, where regulation may need to be adapted if ride-hailing vehicles are not to be controlled by the same regulations as private vehicles (at least during the ride-haling trips, if private vehicles are used for the service). Finally, with an increasing number of ride-haling vehicles cruising the streets for passengers, there may be an increased need for an efficient traffic control/management system, pricing measures or other suitable UVARs (which Jerusalem is already considering) to lower the volume of empty trips.

Climate change: Measures aimed at increasing cycling or depending on large cycling shares in the modal split should be regarded. Some places will be hotter in the future, others will experience longer winters, both things could lower the demand for cycling. On the other hand, climate change could also affect the weather to allow for cycling a larger share of the year. Each city should monitor this development and analyse any changes in the conditions for cyclists and other users of micro-mobility.

Aging population: Measures aimed at cycling and walking should also be adapted to make room for other ability-giving vehicles, for which the need may increase in the future. If implementing access restrictions through geofencing, it must be designed carefully to not hinder service for elderly (both mobility services but also access for service staff in households and home deliveries). The same goes for a dynamic kerb side management system that should be adapted to allow for smooth (and low cost) service transports for elderly.

Internet of Things: Pricing and PZEZ/LTZ measures could be enforced in new ways with the expansion of the Internet of Things, and the future options require or will be facilitated by it. With vehicles and infrastructure being connected to a high extent, a pollution charge, regulations by emissions or vehicle type/dimensions or a timescale scheme could be implemented cheaper and more efficient than today, and investments in enforcement systems made today should consider this.

Lower travel demand: for spatial interventions aimed at slowing or re-directing traffic (road blocks etc.), the impact will be reduced with lower traffic levels. A zone regulated by emissions will also have less impact with lower traffic levels. It may be harder to justify bus/tram priority lanes with lower ridership numbers and with less congestion those priority lanes would not be needed to the same extent. If the city is counting on a certain income from its pricing measures, lower travel demand can jeopardise these numbers.

Higher travel demand: would increase the need and efficiency of most building blocks. If many vehicles are still polluting, the fee level of the pollution charge may need to be revised.

London

The city of London has, plans or considered seven types of spatial interventions, three pricing measures, three pathways to zero-emission or low-traffic zones, and three future options. Further the city has also implemented increased mobility options[3], permit/exemption charge[4], roads on which vehicles are not allowed to stop[5], lorry control[6], economic incentives for fleet renewal[7] and economic incentives for mobility services[8].

Future pandemic: spatial interventions that increase space for walking and cycling are positive since they could enable better physical distancing with active modes of travel. This includes the pedestrian/cycling streets/lanes and redistribution of road/parking space to e.g. wider pavements. However, for measures aiming at increasing shared/public transport measures such as bus/tram priority lanes, drop-off zones for shared mobility and increased options/incentives for transit or shared mobility, the resilience may be lower in a future pandemic. Permanent road blocks may also be hindering emergency/crucial transports in a pandemic (or other disasters).

---

[3] Building block currently not included in the database: All increased sustainable mobility aspects, including mobility hubs, increase sustainable mobility offerings, facilitating vehicle hire, moving/providing additional parking spaces elsewhere, etc.

[4] Building block currently not included in the database: Associated to LEZ/LTZ or parking. Charges are applied and/or differentiated by permit/exemption category, number of vehicles allowed (e.g. prices are higher for the second and third vehicle) or other characteristics (e.g. emission standard, length, size, etc.) Can incorporate a parking charge for on-street or off-street parking in a specified area/street or facility. Can be linked to the building block "Regulation by permit".

[5] Building block currently not included in the database: Red routes are major roads on which vehicles are not allowed to stop. The prohibition extends to stopping for loading or unloading, and to boarding or alighting from a vehicle (except for licensed taxis and the holders of blue badges).

[6] Building block currently not included in the database: To travel outside the Excluded Road Network during the night, lorries >18 tonnes must meet certain requirements, and have registered before entering. Enforcement is done manually with special enforcement officers monitoring vehicles from the roadside.

[7] Building block currently not included in the database: Incentives for the purchasing of greener vehicles or the conversion of older vehicles to cleaner fuels and technologies (retrofit). Can be associated/restricted to the scrappage of an old vehicle (fleet renewal). These are usually differentiated by emission standards/vehicle type and can be associated to vehicle tax exemption.

[8] Building block currently not included in the database: Incentives for the purchasing of public transport and sharing mobility services (discounted cards, free rides) or monetary incentives associated to smartphone-based registered cycling trips (e.g. for bike-to-work).

Pricing measures and access restrictions by emission standards, vehicle type or other could hinder safe travel for critical staff or safe deliveries in a situation where it may be important to be able to travel in a personal vehicle. However, if managed correctly, pricing measures could also be used to facilitate these transports. The same goes for future options such as geofencing to enforce the same regulation. It should be considered how these measures can be adjusted to allow for safe transports in a future pandemic (e.g. special permits for certain staff etc.).

The Gig Economy: work is typically not carried out on the same time and place every day. This could impact pricing or PZEZ/LTZ measures if they are designed to match today's typical peak times, and flexibility should be built into the system so that it can be adjusted if commuting traffic peaks start to smoothen over time. On the other hand, this trend may increase the need for dynamic measures such as dynamic traffic control, which is existing in London's UVAR strategy.

E-commerce: In a possible future where e-commerce makes up a large share of all consumption of goods and services, several of London's measures would need to be adapted to enable efficient deliveries to households. Regulating the delivery transports in the city centre would need to be balanced with the ability for stakeholders to carry out the deliveries that are needed in an efficient way. It should be carefully considered if and how the spatial intervention, pricing and PZEZ/LTZ measures should apply to delivery vehicles – for example, should there be a special regulation on cycling and pedestrian streets for delivery vehicles, and how should it be designed? Should delivery vehicles be allowed on the bus/tram priority line, and are they included in the parking charge? Permanent removal/transition of road side space and road where vehicles cannot stop may need to be accompanied by other solutions for delivery of parcels. The PZEZ/LTZ regulations for emissions and vehicle type/dimensions could possibly have a large impact on the vehicle fleet used for deliveries, therefore it is crucial to design it to match the goals of the city (e.g. many small delivery vehicles or fewer large ones, etc.). With a permit-based system, a boom in e-commerce may lead to an increased number of permits needed.

Electric mobility: London has/is planning a pollution charge and a zone which is regulated by emissions, as well as economic incentives for fleet renewal. It is also considering using geofencing for enforcing fuel restrictions. If the goal is only to reduce emissions, the general trend of electrification of the vehicle fleet will not cause a problem. But if the city is also expecting other positive side-effects of this measure, such as lower traffic volumes in general in the zone, a rapid electrification of the vehicle fleet would reduce the impact of these regulations. On the other hand, a large share of electric vehicles in the fleet will make the road to a ZEZ easier.

Shared mobility: there may also be a need to adapt some of the regulations. For example, are shared vehicles to enjoy benefits that private vehicles are not, for example using the bus/tram priority lanes? When it comes to regulation and enforcement of the pricing and PZEZ/LTZ measures, it may need to be adapted to shared vehicles so that the pricing structure is clear (since vehicle owner and passengers will often not be the same person or household, passengers sharing the same vehicle may not know each other, etc.).

Autonomous and connected vehicles: regulation of speed and other aspects can be enforced in new ways when the vehicles are controlled by software and not drivers. Measures such as visual barriers may be less motivated because all regulations will be processed through the vehicle itself instead of through the eyes and mind of the driver. The impact of parking measures (charging and

permits) may be decreased with self-driving cars since they will probably be parked where fees are low (however the charge/permits, maybe in combination with other measures, could be used to control this situation if designed carefully – to not generate an excess of empty re-positioning driving).

Ride-hailing: A large increase of ride-hailing travel will need efficient pick-ups and drop-offs of passengers in many locations, which could be aided by the drop-off zones for shared mobility. Permanent removal/transition of road side space and roads where vehicles cannot stop may need to be accompanied by other solutions to enable this. Also, as for shared transport, there are options on how to handle ride-hailing transports when it comes to bus/tram priority lanes and PZEZ/LTZ measures, where regulation may need to be adapted if ride-hailing vehicles/trips are to be differentiated from private vehicles/trips. Finally, with an increasing number of ride-haling vehicles cruising the streets for passengers, there may be an increased need for an efficient traffic control/management system, pricing measures or other suitable UVARs to lower the volume of empty trips.

Climate change: Measures aimed at increasing cycling or depending on large cycling shares in the modal split should be regarded. Some places will be hotter in the future, others will experience longer winters, both things could lower the demand for cycling. On the other hand, climate change could also affect the weather to allow for cycling a larger share of the year. Each city should monitor this development and analyse any changes in the conditions for cyclists and other users of micro-mobility.

Aging population: Measures aimed at cycling and walking should also be adapted to make room for other ability-giving vehicles, for which the need may increase in the future. This trend may also further increase the need for drop-off zones and widened pavements, which already exist in London. Any PZEZ/LTZ regulations should be checked to not hinder service transports for elderly. Parking charges should be adapted to personal accessibility levels.

Internet of Things: Pricing and PZEZ/LTZ measures could be enforced in new ways with the expansion of the Internet of Things, and the future options require or will be facilitated by it. With vehicles and infrastructure being connected to a high extent, a congestion, parking or pollution charge, regulations by emissions or vehicle type/dimensions or trip type could be implemented cheaper and more efficient than today, and investments in enforcement systems made today should consider this.

Lower travel demand: for spatial interventions aimed at slowing or re-directing traffic (road blocks etc.), the impact will be reduced with lower traffic levels. A zone regulated by emissions will also have less impact with lower traffic levels. It may be harder to justify bus/tram priority lanes with lower ridership numbers and with less congestion those priority lanes would not be needed to the same extent. If the city is counting on a certain income from its pricing measures (from congestion, pollution or parking), lower travel demand can jeopardise these numbers.

Higher travel demand: would increase the need and efficiency of most building blocks. With high traffic volumes, the fee levels of the pricing measures may need to be revised.

Padua

The city of Padua has, plans or considered 13 types of spatial interventions, three pricing measures, 10 pathways to zero-emission or low-traffic zones, and seven future options. Further the city has also planned for increased mobility options[9] and a permit/exemption charge[10].

Future pandemic: Spatial interventions that increase space for walking and cycling increase resilience for a future pandemic, since they could enable better physical distancing with active modes of travel. This includes the pedestrian/cycling streets/lanes and redistribution of road/parking space to e.g. wider pavements. However, for measures aiming at increasing shared/public transport measures such as bus/tram priority lanes, drop-off zones for shared mobility, a MaaS system etc., the resilience may be lower since shared transport typically will and should be avoided in such a situation. Pricing measures and access restrictions by emission standards, vehicle type or other could hinder safe travel for critical staff or safe deliveries in a situation where it may be important to be able to travel in a personal vehicle. However, if managed correctly, pricing measures could also be used to facilitate these transports. It should be considered how these measures can be adjusted to allow for safe transports in a future pandemic (e.g. special permits/exemptions for certain staff etc.).

The Gig Economy: work is typically not carried out on the same time and place every day. This could impact parking charges or PZEZ/LTZ measures if they are designed to match today's typical peak times, and flexibility should be built into the system so that it can be adjusted if commuting traffic peaks start to smoothen over time – dynamic (real-time) parking charges (already planned) is one way to handle it. The same reasoning holds for the **Work anywhere culture** trend, which also could make commuting patterns less reliable. But even though peaks are less reliable, they are also likely to be less extreme. Generally, these trends may increase the need for dynamic measures such as dynamic traffic control, which is also planned in Padua's UVAR strategy.

E-commerce: several of Padua's measures would need to be adapted to enable efficient deliveries to households. Regulating the delivery transports in the city centre would need to be balanced with the ability for stakeholders to carry out the deliveries that are needed in an efficient way. It should be carefully considered if and how the spatial intervention, pricing and PZEZ/LTZ measures should apply to delivery vehicles – for example, should there be a special regulation on cycling and pedestrian streets for delivery vehicles, and how should it be designed? Should delivery vehicles be allowed on the bus/tram priority line, and are they included in the parking charges? Permanent removal/transition of parking or road side space may need to be accompanied by other

[9] Building block currently not included in the database: All increased sustainable mobility aspects, including mobility hubs, increase sustainable mobility offerings, facilitating vehicle hire, moving/providing additional parking spaces elsewhere, etc.

[10] Building block currently not included in the database: Associated to LEZ/LTZ or parking. Charges are applied and/or differentiated by permit/exemption category, number of vehicles allowed (e.g. prices are higher for the second and third vehicle) or other characteristics (e.g. emission standard, length, size, etc.) Can incorporate a parking charge for on-street or off-street parking in a specified area/street or facility. Can be linked to the building block "Regulation by permit".

solutions for delivery of parcels. The PZEZ/LTZ regulations for emissions and vehicle type/dimensions could possibly have a large impact on the vehicle fleet used for deliveries, therefore it is crucial to design it to match the goals of the city (e.g. many small delivery vehicles or fewer large ones, etc.). With a permit-based system, a boom in e-commerce may lead to an increased number of permits needed.

Electric mobility: Padua is planning a zone which is regulated by emissions. If the goal is only to reduce emissions, the general trend of electrification of the vehicle fleet will not cause a problem. But if the city is also expecting other positive side-effects of this measure, such as lower traffic volumes in general in the zone, a rapid electrification of the vehicle fleet would reduce the impact of these regulations. On the other hand, a large share of electric vehicles in the fleet will make the road to a ZEZ easier. The car-free school area may be even more justified with electric vehicles, because silent cars can risk the safety of children who do not hear the cars coming.

Shared mobility: there may be a need to adapt some of the regulations. For example, are shared vehicles to enjoy benefits that private vehicles are not, for example using the bus/tram priority lanes? When it comes to regulation and enforcement of the pricing and PZEZ/LTZ measures, it may need to be adapted to shared vehicles so that the pricing structure is clear (since vehicle owner and passengers will often not be the same person or household, passengers sharing the same vehicle may not know each other, etc.). A regulation based on permits may also need to be adapted, depending on whether the permit follows the vehicle or the passenger and the enforcement allows for sharing solutions.

Autonomous and connected vehicles: regulation of speed, access and other aspects can be enforced in new ways when the vehicles are controlled by software and not drivers. The impact of parking measures (charging and permits) may be decreased with self-driving cars since they will probably be parked where fees are low (however the charge/permits, maybe in combination with other measures, could be used to control this situation if designed carefully – to not generate an excess of empty re-positioning driving).

Ride-hailing: will need efficient pick-ups and drop-offs of passengers in many locations, which could be aided by the drop-off zones for shared mobility (planned in Padua). Permanent removal/transition of road side space may need to be accompanied by other solutions to enable this. Also, as for shared transport, there are options on how to handle ride-hailing transports when it comes to bus/tram priority lanes and PZEZ/LTZ measures, where regulation may need to be adapted if ride-hailing vehicles/trips are to be differentiated from private vehicles/trips. Finally, with an increasing number of ride-haling vehicles cruising the streets for passengers, there may be an increased need for an efficient traffic control/management system, pricing measures or other suitable UVARs to lower the volume of empty trips.

Climate change: measures aimed at increasing cycling or depending on large cycling shares in the modal split should be regarded. Some places will be hotter in the future, others will experience longer winters, both things could lower the demand for cycling. On the other hand, climate change could also affect the weather to allow for cycling a larger share of the year. Each city should monitor this development and analyse any changes in the conditions for cyclists and other users of micro-mobility.

Aging population: measures aimed at cycling and walking should also be adapted to make room for other ability-giving vehicles, for which the need may increase in the future. This trend may also further increase the need for drop-off zones and widened pavements, which exist and are planned in Padua. Any PZEZ/LTZ regulations should be checked to not hinder service transports for elderly. Parking charges should be adapted to personal accessibility levels.

Internet of Things: Parking charges and PZEZ/LTZ measures could be enforced in new ways with the expansion of the Internet of Things, and the future options require or will be facilitated by it. With vehicles and infrastructure being connected to a high extent, a parking charge or other regulations could be implemented cheaper and more efficient than today, and investments in enforcement systems made today should consider this.

Lower travel demand: for spatial interventions aimed at slowing or re-directing traffic (one-way streets etc.), the impact will be reduced with lower traffic levels. A zone regulated by emissions will also have less impact with lower traffic levels. It may be harder to justify bus/tram priority lanes with lower ridership numbers and with less congestion those priority lanes would not be needed to the same extent. If the city is counting on a certain income from its pricing measures (parking charges), lower travel demand can jeopardise these numbers.

Higher travel demand: would increase the need and efficiency of most building blocks. With high traffic volumes, the fee levels of the parking charges may need to be revised.

Vitoria-Gasteiz

The city of Vitoria-Gasteiz has, plans or considered 17 types of spatial interventions, two pricing measures, five pathways to zero-emission or low-traffic zones, and one future option.

Future pandemic: spatial interventions that increase space for walking and cycling increase resilience for a future pandemic, since they could enable better physical distancing with active modes of travel. This includes the pedestrian/cycling streets/lanes and redistribution of road/parking space to e.g. wider pavements. However, for measures aiming at increasing shared/public transport measures such as bus/tram priority lanes, drop-off zones for shared mobility etc., the resilience may be lower since shared transport typically will and should be avoided in such a situation. Permanent road blocks may also be hindering emergency/crucial transports in a pandemic (or other disasters). Parking charges and ZEZ regulations could hinder safe travel for critical staff or safe deliveries in a situation where it may be important to be able to travel in a personal vehicle. However, if managed correctly, pricing measures could also be used to facilitate these transports. It should be considered how these measures can be adjusted to allow for safe transports in a future pandemic (e.g. special permits/exemptions for certain staff etc.).

The Gig Economy: work is typically not carried out on the same time and place every day. This could impact parking charges or PZEZ/LTZ measures if they are designed to match today's typical peak times, and flexibility should be built into the system so that it can be adjusted if commuting traffic peaks start to smoothen over time. The same reasoning holds for the **Work anywhere culture** trend, which also could make commuting patterns less reliable. But even though peaks are less reliable, they are also likely to be less extreme.

E-commerce: measures may need to be adapted to enable efficient deliveries to households. Regulating the delivery transports in the city centre would need to be balanced with the ability for stakeholders to carry out the deliveries that are needed in an efficient way. It should be carefully considered if and how the spatial intervention, pricing and PZEZ/LTZ measures should apply to delivery vehicles – for example, should delivery vehicles be allowed on the bus/tram priority line, and are they included in the parking charges? Permanent removal/transition of parking or road side space may need to be accompanied by other solutions for delivery of parcels. With a permit-based system, a boom in e-commerce may lead to an increased number of permits needed.

Electric mobility: The car-free school area may be even more justified with electric vehicles, because silent cars can risk the safety of children who do not hear the cars coming.

Shared mobility: there may be a need to adapt some of the regulations. For example, are shared vehicles to enjoy benefits that private vehicles are not, for example using the bus/tram priority lanes? When it comes to regulation and enforcement of the parking charges and PZEZ/LTZ regulation, it may need to be adapted to shared vehicles so that the pricing structure is clear (since vehicle owner and passengers will often not be the same person or household, passengers sharing the same vehicle may not know each other, etc.). A regulation based on permits may also need to be adapted, depending on whether the permit follows the vehicle or the passenger and the enforcement allows for sharing solutions.

Autonomous and connected vehicles: regulation of speed, access and other aspects can be enforced in new ways when the vehicles are controlled by software and not drivers. Measures such as visual barriers may be less motivated because all regulations will be processed through the vehicle itself instead of through the eyes and mind of the driver. The impact of parking charges may be decreased with self-driving cars since they will probably be parked where fees are low (however the charges, maybe in combination with other measures, could be used to control this situation if designed carefully – to not generate an excess of empty re-positioning driving).

Ride-hailing: will need efficient pick-ups and drop-offs of passengers in many locations, which could be aided by the drop-off zones for shared mobility (considered in Vitoria-Gasteiz). Permanent removal/transition of parking or road side space may need to be accompanied by other solutions to enable this. Also, as for shared transport, there are options on how to handle ride-hailing transports when it comes to bus/tram priority lanes and PZEZ/LTZ measures, where regulation may need to be adapted if ride-hailing vehicles/trips are to be differentiated from private vehicles/trips.

Climate change: measures aimed at increasing cycling or depending on large cycling shares in the modal split should be regarded in the light of climate change. Some places will be hotter in the future, others will experience longer winters, both things could lower the demand for cycling. On the other hand, climate change could also affect the weather to allow for cycling a larger share of the year. Each city should monitor this development and analyse any changes in the conditions for cyclists and other users of micro-mobility.

Aging population: measures aimed at cycling and walking should also be adapted to make room for other ability-giving vehicles, for which the need may increase in the future. This trend may also further increase the need for drop-off zones and widened pavements, which exist and are

considered in Vitoria-Gasteiz. Any PZEZ/LTZ regulations should be checked to not hinder service transports for elderly. Parking charges should be adapted to personal accessibility levels.

Internet of Things: parking charges and PZEZ/LTZ measures could be enforced in new ways with the expansion of the Internet of Things – with vehicles and infrastructure being connected to a high extent, charges and regulations could be implemented cheaper and more efficient than today, and investments in enforcement systems made today should consider this.

Lower travel demand: for spatial interventions aimed at slowing or re-directing traffic (one-way streets etc.), the impact will be reduced with lower traffic levels. It may be harder to justify bus/tram priority lanes with lower ridership numbers and with less congestion those priority lanes would not be needed to the same extent. If the city is counting on a certain income from its pricing measures (parking charges), lower travel demand can jeopardise these numbers.

Higher travel demand: would increase the need and efficiency of most building blocks. With high traffic volumes, the fee levels of the parking charges may need to be revised.

Conclusions

While the analysis shows similar insights for many pilot cities, this is due to the overlap of building blocks between the cities. To differentiate the insights, more detailed background information for each city would be needed. The needed information is not regarding the actual building blocks or UVAR strategies but rather on the cities' general status on the different trends. For example:

- National and/or local governance aspects, for example legislation that hinder enforcement technology
- how far has the electrification of the vehicle fleet reached, and is the city (or national level) actively working to increase it?
- Is the general travel demand rising or sinking and what do the city-specific forecasts say?
- And so on.

The resiliency of each UVAR furthermore depends on the city's goals or motivation for the UVARs. The impact of measures can be shifted by different trends, but whether that is a problem or not will depend on what outcomes the city is expecting from the UVAR strategy, except from just limiting car/truck traffic in the city centre. What is the reasoning behind this goal – to lower emissions, increase the city's attractiveness, to free street/parking space for other purposes, …? In some cases, a trend will lower or increase the resiliency when it comes to one goal, but not another.

The assessment shows that it is important to build flexibility into the investments made in forms of UVAR measures. Many trends have the potential to change the conditions dramatically, and the uncertainties in outcomes of different trends are large. Therefore, to be resilient cities must be able to re-design or update the UVAR measures in a couple of years if needed. This concerns investments in e.g. technological systems, spatial interventions as well as communication of regulations. Cities may consider if there are there technological systems that will be needed with high certainty and that could be used for many purposes. One way to do this is to refer to the Market Consultation (ReVeAL milestone 10)/the Innovation Observatory and compare insights found there to the city's strategy and goals.

In general, the assessment found few signs of very low resilience. Most issues could be handled by careful design of the measures and built-in flexibility. This report could therefore be used as an input to the pilot cities' design phase.

Appendix: Description of Building Blocks

Building block	Description
Spatial interventions - School street - Car-free school area	Area around a school that is (partially or temporally) inaccessible to motorized vehicles.
Spatial interventions - School street - K&R	Area around a school where the time motorized vehicles can stop is limited (to the time needed to drop off children).
Spatial interventions - School street - Speed regulated	Area around a school where (partially or temporally) speed for motorized vehicles is regulated.
Spatial interventions - Cycling street -	Non-segregated street with right of way for cyclists, who are the priority users. Cars are guests and can be forbidden or discouraged (depending on country specific traffic regulation) to overtake cyclists. Cycling streets are characterized by a custom red surface or road marking at the entrance of the street.
Spatial interventions - Traffic filter - Road block	Physical barrier to disable motorized vehicle access.
Spatial interventions - Traffic filter - Capacity restraint - limiting volume or type of vehicle	Physical barrier to limit the volume of (a certain type of) motorized vehicles passing through (and stopping in) the city (e.g., fixed poles or blocks, redesign of the streets, etc.).
Spatial interventions - Traffic filter - Visual Barrier	Visual barrier to limit the volume of motorized vehicles passing to (and stopping in) the city (e.g., road marks, traffic signs, etc.).
Spatial interventions - Traffic filter - Through traffic ban	A road traffic sign is required, whatever UVAR is implemented. Some regulations are implemented solely with a through traffic road sign on a single street, or a whole urban area. Could be enforced with cameras.
Spatial interventions - Traffic filter - One-way street	Restriction to one-way right of passage to a street for motorized vehicles.
Spatial interventions - Removing parking or road space - Parklet	Small public space or green space created as a public amenity on or alongside a pavement, especially in a (or several) former roadside parking space(s).
Spatial interventions - Removing parking or road space - Widen pavement	The removal of parking space to allow for the widening of the pavement.
Spatial interventions - Removing parking or road space - Drop-off zone shared mobility	Parking space is converted to space for dropping of vehicles of (primarily free floating) shared mobility systems.
Spatial interventions - Removing parking or road space - Logistics bay (mini-hub)	Designated accessible parking spaces.

Building block	Description
Spatial interventions - Cycle lane - Redistribution of road space	Reallocating and redesigning road space for cyclists.
Spatial interventions - Cycle lane - Conversion of parking lane	Reconversion of parking space for cyclists.
Spatial interventions - Pedestrian street - Mixed used cycling-pedestrians	Streets allocated and designed for pedestrians, allowing for mixed-use where cyclists (and possibly other transport modes) are allowed as guests.
Spatial interventions - Pedestrian street - Residents only vs other groups	Streets allocated and designed for pedestrians, only allowing resident (or another specific group) access.
Spatial interventions - Pedestrian street - Temporal pedestrian street	Streets allocated and designed for pedestrians during a certain time period.
Spatial interventions - Bus/tram priority lane -	Lane designated for bus or tram movement, resulting in priority for public transport (and avoiding traffic delays having an impact on the PT circulation).
Spatial interventions - Zone de rencontre/Begegnungszone/woonerven -	Urban planning tool dedicated to regulating traffic and allowing different users (pedestrians, cars, bicycles, etc.) to cohabit in a non-segregated space with a maximum allowable speed of 20km per hour.
Pricing measures - Congestion charge - Applied to a perimeter or an area	It is a daily charge to be paid for driving through a designated restriction boundary and/or within the restriction area. Cameras read the plate number as the vehicle drives through the perimeter and/or on enforced inner roads and check it against a database of registered vehicles.
Pricing measures - Congestion charge - Applied to specific points	Vehicles are charged for travelling through a given location or series of locations on the road network.
Pricing measures - Congestion charge - Distance-based charge	Tolls are proportional to the distance travelled, GPS installed inside the vehicle
Pricing measures - Pollution charge - Applied to a perimeter or an area	Vehicles with high-polluting engines driving through a designated restriction boundary and/or within the restriction area are charged. Cameras read the plate number as the vehicle drives through the perimeter and/or on enforced inner roads and check it against a database of registered vehicles.
Pricing measures - Parking charge - Dynamic price (real time)	Pricing of parking spaces is updated periodically during the day to match demand levels.
Pricing measures - Parking charge - Fixed price	Vehicles are charged to occupy parking spaces. Prices are fixed according to areas of the city and/or time of the day.

Building block	Description
Pricing measures - Parking charge - From on-street to off-street parking	Vehicles are charged to occupy parking spaces. Prices are higher on-street than in parking infrastructure facilities to gradually reduce the presence of cars in the city and improve the quality of public spaces
Pricing measures - Traffic flow management - Time-based charge	Vehicle charges are based on the amount of time a vehicle is driven. The system calculates the time the vehicle remained inside the boundary and computes the fee due for access (and parking).
Pricing measures - Traffic flow management - Distance-based charge	Vehicle charges are based on the distance a vehicle does in a particular area.
Pricing measures - Urban logistic charge - Mobility credits	This model establishes the total amount of "acceptable" emissions within a specific zone of a city and allocates them to economic operators. Operators can "purchase" freight transport services that are not subject to additional access charges or restrictions. Once credits have been used up, operators have the possibility to purchase more.
PZEZ/LTZ[11] - Regulation by emissions -	Restricting vehicles by their emissions. This is usually phased, and by vehicle type / trip. A low emission zone with emission standards by fuel and vehicle type. This allows focusing on different vehicle types, depending on their contributions to emissions. It also gives a framework to ZEZ.
PZEZ/LTZ - Regulation by vehicle type and/or dimensions	Regulating by vehicle type. This can be by weight over a certain weight or size (length, width), or by the specific vehicle type (car, van, lorry, coach, minibus, special), depending on their contributions to emissions, focusing on HDV/LDV... Could also be a combined scheme with emissions, time frame, trip purpose, phasing
PZEZ/LTZ – Regulation by trip type	Regulation of the trip type enables specification for (and inclusion or exclusion from the regulation), by for example deliveries, residents, through traffic. The permits can be time limited, or permanent. Careful consideration and definition of who is allowed into the zone can ensure that the scheme appropriately allows in (only) those it is aimed at. Deliveries are regulated, usually by a time window, but also other requirements can be added to give more (or less) freedom. Residents or specific users are often given additional flexibility in schemes.
PZEZ/LTZ - Scheme timescale – Programmed Time window (e.g. night-time/ time of day/week/year/season)	Time can be used in many ways. To have an UVAR only when the issue is acute. Examples: night time deliveries allowed if meeting requirements (otherwise not), or time windows for entry, restrictions when pollution is higher in wintertime, limitation during summer/tourist season or at daily peak times.

[11] Pathways to zero-emission zone/low-traffic zone

Building block	Description
PZEZ/LTZ - Scheme timescale – Reactive Operation (e.g. by pollution /congestion (/pandemic ….))	Time can be used in many ways. To have an UVAR only when the issue is acute. Examples: Pollution "emergency schemes" restrictions during times when the pollution levels are/have been/are predicted to be high, or reducing the number of (at certain times) lorries to reduce congestion at peak times / improve safety for school routes.
PZEZ/LTZ - Scheme timescale - Phasing: E.g. introductory warning letters, tightening standards, ...	Time can also be used to phase schemes in, both in telling people about the tightening scheme in advance, and giving people an introductory enforcement phase, where for the first section of time violators are sent a letter saying "you will be fined for this journey in the future, here is just a warning letter", as a way of raising knowledge of the scheme, and softening the start
PZEZ/LTZ - Regulation by permit - Permit to travel	Permits can be an important way to implement an UVAR, both for travelling (and parking) permission to enable Limited Traffic Zones; but also in controlling aspects around (re-)building. A (non-planning) permit can be through a windscreen sticker and/or the vehicle registration plate being on a database. Where an UVAR is controlled with ANPR, there is effectively always by a permit (be that a specific "white list" (for allowed or exempted vehicles) or because the vehicle is registered with an allowed Euro standard on the (national) vehicle database). While Low Emission Zones can be regulated by e.g. an emissions sticker/national database entry, which is technically a permit, it is not specific permission to enter one single city area. However, it is difficult to regulate (and importantly enforce) a LTZ without a specific permit to enter that city. Permits are most often used in Limited Traffic Zones, where vehicles are generally excluded, and certain vehicles allowed entry (e.g. residents, delivery, individual trips).
PZEZ/LTZ - Regulation by permit - Vehicle ownership permit	
PZEZ/LTZ - Regulation by permit - Permit to park (e.g. residents/business)	Permit to park a vehicle (on or off street) within the area (or to drive to the car parking space).
PZEZ/LTZ - Regulation by permit - Permit to build car parking space	A condition of planning permission can be used to reduce the impact of vehicles. It can either be used in a number of ways. Planning permission can be used in a wider sense to reduce the need to travel. It can also be used to limit the number of car parking spaces allowed during development (or re-development / change of use). It can also be used to place requirements on the (on and off-road) vehicles that are used during the building phase, for example that clean vehicles (as well as other good and dust reducing construction practices) are used. The example used here is requiring the use of clean(er) construction vehicles (non-road mobile machinery) (as well as other good and dust reducing construction practices). This can be seen as a "LEZ for construction vehicles", and it can be phased in with larger construction sites and/or vehicles etc.

Building block	Description
ZEZ – Regulation by other	There are many other aspects that can be regulated. Some of the key aspects are collated here. For example, additional entry time to restricted zone for those that meet emissions and load-factor requirements, additional safety features are required for lorries to improve safety for sustainable mobility modes such as cycling and walking. Phased requirement on the largest firms, which have a better capacity to change than single van operators. Car-free areas (together with logistics regulation) can be a key way to implement a ZEZ - and one with the most impact. This is taken forward within spatial intervention. Conversely, car free areas may need to allow access for delivery and servicing, which needs to be regulated.
Future options - enabler - Geofencing - Enabler for fuel restrictions	Specification of geographic areas in a digital map where certain rules apply for vehicles' attributes and behaviours. E.g. force electric propulsion in the powertrain control. Requires connected vehicles, legal adjustments and adapted vehicle control.
Future options - Geofencing - Enabler for access restrictions	Specification of geographic areas in a digital map where certain rules apply for vehicles' attributes and behaviours. E.g. blocking of unauthorised vehicles. Requires connected vehicles, legal adjustments and adapted vehicle control.
Future options - Geofencing - Enabler for speed restrictions	Specification of geographic areas in a digital map where certain rules apply for vehicles' attributes and behaviours. E.g. limitation of speeds. Requires connected vehicles, legal adjustments and adapted vehicle control.
Future options - Geofencing - Other	Specification of geographic areas in a digital map where certain rules apply for vehicles' attributes and behaviours. Requires connected vehicles, legal adjustments and adapted vehicle control.
Future options - Connected vehicles and infrastructure -	Broad category of measures that will enable more future-oriented UVARs through allowing information and data transfer between vehicles and infrastructure
Future options - Autonomous vehicles -	Vehicles operating without a human driver. Access restrictions will be an integral part, especially if vehicles are also connected
Future options - Digital twins/data sharing platforms/standards/systems -	A virtual system which is fed with real time data from the traffic and infrastructure in an area/a city. Solutions can be tested using simulations. Real time information sharing enables better decision-making.
Future options - Dynamic traffic signalling/management/ITS/rerouting -	Central traffic management system that controls traffic lights, information signs, etc. and communicates the signalling in a dynamic way to the users.
Future options - Dynamic Space Management - Kerb side management	Dynamic regulation of use of the kerb side. By restricting or redirecting parking, deliveries, pick-up/drop-off of passengers, access to the area is restricted in an indirect way

Building block	Description
Future options - Dynamic Space Management - Parking management	Dynamic regulation of use of the parking space. By restricting or redirecting parking, access to the area is restricted in an indirect way
Future options - Sharing/mobility hub/MaaS/rented micro-mobility/… - MaaS system	The city offers attractive, easy to use, economic alternatives for mobility and transport in the area, to lower demand for private vehicle access
Future options - Sharing/mobility hub/MaaS/rented micro-mobility/… - Mobility hub	The city offers attractive, easy to use, economic alternatives for mobility and transport in the area, to lower demand for private vehicle access
Future options - Sharing/mobility hub/MaaS/rented micro-mobility/… - Easy access micro-mob renting	The city offers attractive, easy to use, economic alternatives for mobility and transport in the area, to lower demand for private vehicle access
Future options - Sharing/mobility hub/MaaS/rented micro-mobility/… - Transit, waterways, freight consolidation centre…	The city offers attractive, easy to use, economic alternatives for mobility and transport in the area, to lower demand for private vehicle access
Future options - High-occupancy vehicles - Policy to reduce single-occupancy	Regulation of access to lanes, areas or differentiated pricing based on vehicle-occupancy (the number of passengers in the car)