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Item 9 of the provisional agenda

**Urban Mobility and Public Transport:**

**Pan-European master plan for cycling and**

**Sustainable mobility and urban planning**

## **Draft version of the Handbook on Sustainable Urban Mobility and Spatial Planning**

**Submitted by consultants**

### **Introduction**

This document contains the draft Handbook on Sustainable Urban Mobility and Spatial Planning as prepared and submitted by the consultants hired as part of an extra-budgetary project funded by the Government of the Russian Federation. The Handbook is being prepared in the framework of the Transport Health Environment Pan-European Programme (THE PEP) and is planned to be adopted at THE PEP High-Level Meeting in 2020 following a decision of the THE PEP Steering Committee. WP.5 delegates are invited to consider the draft text of the Handbook and provide their comments and feedback during the upcoming thirty-second session to facilitate a decision on the publication at the next THE PEP Steering Committee meeting in October 2019.

# **HANDBOOK ON SUSTAINABLE URBAN MOBILITY AND SPATIAL PLANNING**

A practical guide featuring over good practices and case studies on integrating transport, environmental, health and quality of life objectives into urban and spatial planning policies

**Preliminary draft V10**

**August 20 2019**

*Greenhouse gas (GHG) emissions from transport have increased over the last three years, whilst average CO2 emissions of new passenger cars increased for the first time in 2017. The sector remains a significant source of air pollution, especially of particulate matter (PM) and nitrogen dioxide, although these emissions have been reduced in the last decade. It also is the main source of environmental noise in Europe.”*

Source: Transport and Environment Reporting Mechanism (TERM). *Progress of EU transport sector towards its environment and climate objectives*. Nov. 22 2018

*In 2014, the THE PEP Paris Declaration enhanced the priority goals previously adopted in Amsterdam with a new strategic direction “to integrate transport, health and environmental objectives into urban and spatial planning policies”.<sup>1</sup>*

*In 2019-2020, the THE PEP process has to move to a next level and include sustainable urban mobility as a supporting factor the implementation of the 2030 Agenda and the Sustainable Development Goals as well as the Paris Agreement.*

THE PEP Handbook Sustainable Transport and Urban Planning 2019

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<sup>1</sup> Source : UNECE THE PEP, Paris Declaration 2014

## Foreword



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# Chapter 1. Sustainable Urban Mobility Today & Tomorrow

## Chapter 1. Sustainable urban mobility today & tomorrow

### 1.1 The big picture: climate, health, stress and mobility

The shift towards a predominantly urban world has been formally assessed around the turn of the millennium but it took over a decade to start building multilateral regulatory frameworks on climate, sustainability and soon on biodiversity.<sup>2</sup>

Together with national governments and sometimes even more actively, local and regional governments, a wide range of stakeholders and interest groups from the civil society and the private sector have actively grasped change as they are on the frontline of daily challenges.

Mobility, health, greener mobility and infrastructures, air quality, CO<sub>2</sub> and green house gas (GHG) emissions, are among the most pressing issues faced by communities across the globe and cities are turning to accelerated environmental transformations and adaptation at the local level. This takes place in a larger context of global industry shifts including digitalization and the rise of on-demand mobility systems, showing great potential to support the development of new sustainability mobility plans. And yet, the world still has to move from piecemeal experimental approaches to core structural changes, as highlighted throughout the present report.



***“This handbook of the Transport Health Environment Pan European Program led by UNECE (THE PEP) is designed to foster concrete and applicable solutions and to support local governments and leading stakeholders in moving towards healthier and yet affordable urban systems.”***

In a world with over half of the urban population living in expanding metropolitan areas, and an expected 600 million new metropolitan inhabitants by 2030, mayors gathered at the U20 Summit in Tokyo in May 2019 jointly affirmed that *“building sustainable and resilient cities is crucial to safeguard the quality of life, livelihood and health of our city dwellers”*<sup>3</sup> While such changes obviously include mobility and transportation the present handbook of the Transport Health Environment Pan European Program led by UNECE (THE PEP) is designed to foster concrete and applicable solutions and to support local governments and leading stakeholders in moving towards healthier and yet affordable urban systems.

According to the IPCC Special Report on Global Warming of 1.5°C, the pathways limiting global warming to 1.5°C would require rapid and far-reaching transitions in energy, land, urban and infrastructure (including transport and buildings), and industrial systems. These “system transitions” are unprecedented in terms of

<sup>2</sup> The Paris Agreement only came with the COP21 in 2015, as the adoption of the Agenda 2030 and the framework of the SDGs. The New Urban Agenda was adopted in Quito in 2016 at Habitat III. In 2020, the COP15 “Biodiversity” is expected to launch a new convention on biodiversity protection.

<sup>3</sup> Source Urban 20 Tokyo Mayors Summit Communiqué, May 2019



scale. They imply “*deep emissions reductions in all sectors, a wide portfolio of mitigation options and a significant upscaling of investments in those options*”.<sup>4</sup> As is illustrated in the present report (see chapter 4, 6 in particular), such change has started, with spectacular examples coming from China.

The authors of the 1,5°C report point out to “*economic, institutional and socio-cultural barriers (that) may inhibit these urban and infrastructure system transitions, depending on national, regional and local circumstances, capabilities and the availability of capital*”. The present THE PEP handbook on sustainable transport and urban planning builds on these indications as a key to accelerate the transitioning towards sustainable mobility. As illustrated in particular in the chapters 2 and 3, ensuring a strong transformation pathway of the transportation sector, with the share of low-emission final energy rising from less than 5% in 2020 to about 35–65% in 2050 to reach the 1,5°C limit, largely depends on better integrated sustainable mobility and urban plans.

The local expectations and global calls for rapid transitioning towards more sustainable urbanization models take place in a context where health and stress levels in cities are growingly assessed as a global issue. In a table of interactions between all 17 Sustainable Development Goals (SDGs), the Global Sustainable Development Report 2019 shows how much SDG11 on *Making cities and human settlements inclusive, safe, resilient* can have negative impacts on several others and in particular climate change (SDG 13), *Life under Water* (SDG14), *Life on Land* (SDG15), if not properly managed.<sup>5</sup>

The latest report of the Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services (IPBES) issued in May 2019 also highlights how much the future of urban development is to be integrated in a bigger picture, with roads and mobility infrastructures to play a major role in meeting not only climate goals but the future biodiversity targets.<sup>6</sup>

#### Urbanization, Development and Socioeconomic Issues (IPBES, May 2019)

>100%: growth of urban areas since 1992

25 million km: length of new paved roads foreseen by 2050, with 90% of construction in least developed and developing countries

+/-50,000: number of large dams (>15m height) ; +/-17 million reservoirs (>0.01 ha)

105%: increase in global human population (from 3.7 to 7.6 billion) since 1970 unevenly across countries and regions

50 times higher: per capita GDP in developed vs. least developed countries (...)

## 1.2 Addressing complexity

In the beginning of 2019, the European Commission published a report on enhancing resilience of urban ecosystems through green infrastructure. This report summarized the main outcomes of *EnRoute*, a science-policy project, managed by the European Commission and funded by the European Parliament, involving 18 ‘city labs’ across Europe. The project provides new knowledge on how Urban Green Infrastructures (UGI) could support urban policy-objectives at different stages of the planning process and at a variety of spatial scales.<sup>7</sup>

<sup>4</sup> IPCC Special Report on Global Warming of 1,5°C, October 2018.

[https://report.ipcc.ch/sr15/pdf/sr15\\_spm\\_final.pdf](https://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf)

<sup>5</sup> Global Sustainable Development Report 2019. Draft report presented during July 2019 High Level Political Forum [http://www.europarl.europa.eu/cmsdata/160761/GSDR2019\\_for\\_EP%20hearing\\_20190207\(final\)%20\(003\).pdf](http://www.europarl.europa.eu/cmsdata/160761/GSDR2019_for_EP%20hearing_20190207(final)%20(003).pdf)

<sup>6</sup> <https://www.ipbes.net/news/Media-Release-Global-Assessment>

<sup>7</sup> *Enhancing resilience of urban ecosystems through green infrastructure* (EnRoute), European Commission

There is little doubt that the success of transportation networks transformation and the development of sustainable mobility systems depends on how urbanization will be managed and governed in the next decade but this means that strong choices are made.

As part of the debates while the new law on mobility was passed in the French Parliament in the summer of 2019, some argued that the simplest way to promote sustainable urban mobility would be... to decrease the need to move and curb down the number of trips. Meanwhile in Italy, as part of the adoption of a new Sustainable Urban Mobility Plan in the end of 2018, the State undersecretary for economic development insisted on prioritizing the general interest over individual positions.

In practice, the road towards sustainable mobility will require advanced political skills to navigate between principles, consensus building and further research and policy-making to enlighten the way forward.



The move from *green infrastructure* to *urban green infrastructure* as recently assessed by the European commission is the latest chapter in a story which has become global.

In the past twenty years, the role of infrastructures to promote and sustain economic growth has been growingly acknowledged.<sup>8</sup> Over the past decade, the need for green infrastructures has been emphasized, such as climate

friendly railways and waterways, clean and renewable energy projects etc.<sup>9</sup> The *future of infrastructure* and the *greening of infrastructure* combining engineering, policy making and finance has been among recurrent topics within G20 since 2008, including G20 Japan in 2019.<sup>10</sup>

As illustrated in the present THE PEP report chapters 5 and 6, the development of healthier urban mobility systems depends on how local governments can reap out the benefits of global societal changes and the development of renewable energy. It also depends on how they can manage a new generation of designated intelligent transport systems (ITS).

One good illustration of contemporary interlinkages between local and global levels as well as between the making of plans and technology shifts is the global impact of the conversion of electro mobility of taxi and buses fleets in China's major urban areas such as the Shenzhen, Guangzhou, Macau Hong-Kong mega region.

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(Brussels) 28 February 2019. Access Date: 23 March 2019. <https://ec.europa.eu/jrc/en/publication/enhancing-resilience-urban-ecosystems-through-green-infrastructure-enroute>.

Urban Green Infrastructure (UGI) refers to strategically managed networks of urban green spaces and natural and semi-natural ecosystems situated within the boundary of an urban ecosystem. These high-quality, biodiversity-rich areas could help make cities more sustainable and contribute to solve many challenges, such as air pollution, noise, climate change impacts, heat waves, floods and public health concerns

<sup>8</sup>Peirce et al., 2006-8, Buchoud, 2008, Buchoud et al., 2019

<sup>9</sup> *Green Infrastructures* refer to interventions to preserve the functionality of existing green landscapes (including parks, forests, wetlands, or green belts), and to transform the built environment through phytoremediation and water management techniques and by introducing productive landscapes (IPCC 2014b). This can be termed blue infrastructure if aquatic ecosystems are concerned (European Environment Agency 2017). Source: *Global Research and Action Agenda on Cities and Climate Change Science, 2018*

<sup>10</sup> <http://www.cerclegrandparis.org> T20 Japan Communiqué, G20 Osaka Summit Final Declaration §13

**“As illustrated in the present report, the development of healthier urban mobility systems depends on how local governments can reap out the benefits of global societal changes and the development of renewable energy together with a new generation of designated intelligent transport systems (ITS).”**

Combined with 5G systems, artificial intelligence development and investments in mobility systems aiming at harvesting data, this is not only changing the urban landscape and improving the air quality locally. Chinese EV buses are sold globally. Bike free-floating companies have raised hundreds of millions in capital and the yellow or orange bikes can be seen in cities the world over. The combination of new vehicles and digital processes has a direct impact on traffic management which is becoming real time at massive scale, as well as on the definition of future urban development projects.

In the past decades or even beforehand at the turn of the 19<sup>th</sup> century, such movements as garden cities, hygienism, rationalist construction (mouvement moderne) have all combined urban models, health and well-being issues, and mobility. In the contemporary context of rising levels of stress and pressure on urban dwellers, there is no clear pathway regarding optimal cityshape ensuring equality.<sup>11</sup>

Following over a decade of loosely coordinated action and policy-making at combined micro, metro and macro-scales<sup>12</sup> we have reached a turning point. As illustrated by the assessment of the nationally determined contributions (NDCs) to reach the Paris agreement and the voluntary national reviews (VNR) of the SDGs, the call for cross-sectoral approaches to urbanization, mobility and infrastructure development is getting higher on global agendas. Now is the time to transform the call into action and into applicable policies.<sup>13</sup>

### **1.3 Taking action: rebuilding models, profiting by rising environmental awareness**

In the transition towards the de-coupling of economic growth from carbon emissions, a new approach to infrastructure projects is emerging, connecting *hard* and *soft* infrastructures, infrastructure finance and users' behaviours, civil and financial engineering, changing industry processes, and the development of inclusive infrastructures. This comes as mobility is fast changing with digitalization offering a wealth of new opportunities to move from siloed to platform or even distributed approaches.<sup>14</sup>

In the present THE PEP report, we have developed numerous case studies from across the UNECE region and even beyond, showing that sustainable urban transport and planning ultimately relies on the development of public transport systems and corresponding infrastructures. In that regard, we also advocate that future sustainable mobility plans should be backed by public and private sources of funding. Perhaps new global regulations should be

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<sup>11</sup> Salat et al., 2012; Ahfeldt, 2017

<sup>12</sup> The adoption of the United Nations Agenda 2030, including the Sustainable Development Goals (SDGs) and SDG11 on “sustainable, safe and resilient cities and communities” took place in the fall of 2015. The Paris 21<sup>st</sup> Conference of the Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC) setting up new goals to mitigate climate change and curb CO<sub>2</sub> emissions also took place in the fall of 2015. The Habitat III Summit which issued the New Urban Agenda took place in Quito a year later in 2016. The rise of a global agenda on biodiversity is only happening now, with the 15<sup>th</sup> meeting of the Conference of the Parties to the Convention on Biological Diversity (COP15) to be hosted by China in 2020.

<sup>13</sup> Proposals such as the *Planetary Boundaries* (2009) or the reinforcement of the *Anthropocene Theories* (2009, 2016) offer new horizons for a more holistic approach to current global transformations but they have remained mostly conceptual.

<sup>14</sup> Source of the illustration. *Circuler, quand nos mouvements façonnent la ville*. Paris, Cité du patrimoine et de l'architecture, 2012. J.M. Duthilleul curator. <https://www.citedelarchitecture.fr/fr/exposition/circuler-quand-nos-mouvements-faconnent-les-villes>



implemented so as to balance the impact of venture capital appetite for individual mobility systems. The total market value of the world's largest global ride-hailing companies was about US\$ 100 billion in 2018, a calculation based upon the market value of the companies Lyft, Grab, GoJek and Uber as of December 2018. Uber stock-exchange market value alone was worth US\$ 71 billion in 2018, which is more than the combined total investment costs for the London Crossrail project and the Grand Paris Express metro network serving the Greater Paris metro area by 2030, two of the world's largest metropolitan transportation infrastructure projects.<sup>15</sup>



We strongly support the development of active mobility policies, as illustrated in the chapter 4 of the report. Such policies are even a critical part of broader public health policies. Yet, we also believe that active mobility support healthier urban lifestyles need to take into account the impacts of global trends at local levels. Cities have to be more closely associated to the global talks about the future of infrastructures and we hope that the present report will help demonstrate that global infrastructure projects must serve and support citizen-oriented, health focused mobility policies, plans and investments.

In several *countries* across Europe now, or at least in a number of *cities*, the response of spatial planning goes radically *against* private motor cars, especially when they are powered with fossil fuel. This goes with intense debates and controversies, as illustrated in Madrid in June 2019 with huge demonstrations opposing the newly elected municipal government's proposal to cancel the creation of a low emission zone in the center of the city...a proposal which was in its electoral program.

Throughout Europe, there is a growing convergence of real estate development and public policies featuring sustainable development. In the Russian Federation, programs such as the promotion of "comfort of living" are supporting people-centered development policies including better quality public space.

With this handbook, as illustrated in chapter 7 and summarized in the final recommendations of chapter 8, we advocate that urban masterplans across UNECE countries should be converted into integrated urban and transportation development strategies with rolling investment plans in sustainable mobility systems. We call the UNECE Working Party on Transport Trends and Economics (WP5) to promote such a policy-change widely, as a way to guarantee long-term finance of public transportation systems.

Despite obvious trends towards less car dependency and more integrated sustainable spatial planning and mobility policies, there is much to do, without any chance for one-size-fits all approaches. Whereas in Switzerland, for instance, civil society organisations such as the Association Transports et Environnement are being joined by federal organisations to support "housing without cars" projects, growth and development priorities remain a priority, such as in emerging economies.

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<sup>15</sup> Cross rail cost is about US\$ 20,1 billion (source: GLA 2018) and Grand Paris Express cost is about € 38 billion or US\$ 43 billion (source: Société du Grand Paris, 2018)

***“We have developed numerous case studies from across the UNECE region and even beyond, showing that sustainable urban transport and planning ultimately relies on the development of public transport systems and corresponding infrastructures.”***



**Illustration: the *Burgrunder zero car development* in Bern-Bümpliz (Switzerland – source bls AG). Below: Abu Dhabi Plaza project under development in Astana, Kazakhstan (source: AdenMetal)**

Designated “smart city” or mega-projects are rivalling in size and height across central Asia. Although such developments, being pushed by capital flows from the Emirates or Asia, include green features and certification, the no-car approach is yet to be advocated for. From integrated and R&D fuelled development projects such as in Amsterdam to more classical and yet rapidly changing planning norms such as in Tashkent (Uzbekistan), the UNECE region definitely displays a wide array of nuances.

Beyond the differences between inherited norms and planning and engineering traditions, challenges are common, starting with fighting air pollution, reducing CO2 emissions, and reversing urban sprawl.

As the society is changing and technology brings new opportunities to scale up innovations, this is the right time for action.





## **Chapter 2.**

# **Spatial planning for sustainable urban mobility and accessibility**

## Chapter 2. Spatial planning for sustainable urban mobility and accessibility

### 2.1 Spatial planning and typologies of urban development: disruptions and transformations



#### 2.1.1 Spatial planning in times of change

**Figure 2.1. The 2016 New Urban Agenda adopted by the United Nations**

Spatial planning, be it at country, region, city or neighbourhood level, is a key for territorial development. It stands at the crossroads of land use, real estate industry, infrastructure development. In the context of global urbanization, spatial planning, which used to be based upon long term forecasts, is affected by systemic disruptions or transformations. Climate change, globalization of economic and capital flows, natural hazards, the growth of international migrations are powerful game changers at all scales.

Planning of spatial organization of territories or spatial planning is a key instrument for establishing long-term, sustainable frameworks for social, territorial and economic

development both within and between countries. Its primary task is to enhance the integration between such sectors as housing, transport, energy and industry, and to improve national and local systems of urban and rural development, also taking into account environmental considerations. The nature of spatial planning substantially sets out the conditions in which the transport demand of the population and that of the economy is shaped and along with the characteristics of the transport system relevant to its operations.

The concept of spatial planning is often associated with its private ownership variations such as land-use planning, urban and regional planning, transport planning and environmental planning. Spatial planning can be implemented at various levels: at local, regional, national and international levels.

As the economy is being further digitalized, place-making is also changing. Of all changes affecting cities across Europe and the wider UNECE region, the quest for mobility might be the most symptomatic. At any moment of any given day, more than 3 million people are up in the air flying. The number of cars on our streets is steadily growing. Global trade and the individualization of delivery of goods is fueling roads and streets with an unprecedented number of delivery vehicles.

In 2016, the United Nations adopted the New Urban Agenda at the Habitat III Summit in Quito. This document promotes the implementation of National Urban Policies based upon integrated and mixed use urban development. It also promotes the role of urban planning as a mean to control land and ensure a universal *“right to the city”*, including access to basic services, housing and employment and *“access to the benefits and opportunities that cities can offer.”*

The issue of mobility is featured over a dozen times in the text of the New Urban Agenda, as a key to limit urban sprawl, support balanced urban and metropolitan development, reduce the social and environmental costs of congestion and pollution.

UNECE countries have strong but quite different urban planning traditions, be it in the European Union, in the Russian Federation and the CIS countries, in North America. Since the end of the Cold-War, market-driven global trends have played a strong unifying role but as global challenges are rising, it could be relevant to build on such a rich common heritage.



### 2.1.2 Uncertainties about models

Since the turn of the millennium, many cities have engaged in long-term visioning exercises, with infrastructure planning as a key. From New-York to Tokyo, Sydney to London, Moscow to Shanghai, Singapore to Paris, the UAE or recently Saudi Arabia, such *grand* plans have led to the adoption of significant investment packages. A number of cities in India, South-East Asia or Central Asia are now following the way. Despite the lack of reliable and internationally comparable data and the routine presence of lagging indicators (Leff, Petersen, 2015), the *Greater Paris* or *Greater Moscow*, the *New-York* or *London Plan*, etc... nurtured an overall impression of progress and a new literature about *Mayors Ruling the World* (Barber, 2013).

**Figure 2.2 Different urban structures, urban planning traditions and global trends across cities in the UNECE region (Utrecht new central station in The Netherlands, Kazan in the Russian Federation)**

Yet, the promotion of innovation and the development of new large scale mobility systems have not prevented a global systemic decline in housing affordability (UN Habitat, 2018, Schumann, 2019). The governance of complex metro areas is generally weak (Lanfranchi et al., 2017) and the adverse effects of infrastructure development on spatial inequalities underestimated (Combes and Lafourcade, 2011, Fingleton and Szumilo, 2019). The connectivity between investments in large scale infrastructure projects and the building of social capital has been neglected by neo-classics and post-Keynesian economics.<sup>i</sup>

There is a failure in the promotion of compact urban development models.<sup>ii</sup> Apart from questionable success stories such as the densification of Vancouver downtown, contemporary urban growth consumes three times more land per capita than in the 1990's (Angel, Galarza et al., 2016), which is true in all parts of the world.<sup>iii</sup> Transit Oriented Development (TOD) principles have been developed since the early 1990's (Calthorpe, 1993), but as of 2017, there are still no globally approved TOD standards. Smart cities is a concept that has been widely developed since the years 2005/6, but there are no global smart cities standards. ISO has been working on sustainable community norms since 2012. IEEE is also working on synthetic norms, but there are no global standards out of sectoral approaches.



### 2.1.3 Confusion and opportunities in the spheres of mobility and transportation

Unregulated urban growth is the cradle of urban financial success stories bringing hope but also confusion. According to McKinsey, \$110 billion has been invested in mobility startups between 2010 and 2016 with most of it going to startups in the sharing and autonomous vehicle spaces and the bulk of the investment coming out of Silicon Valley.<sup>iv</sup> The global venture capitalist community has been looking for the next big opportunity and believed it to be mobility (not infrastructures), causing systemic disruptions in urban governance, infrastructure finance and planning models.<sup>v</sup> The stock-exchange value of ride-hailing companies now often exceeds some of the largest infrastructure investment packages across the globe.

Subsidized public transit has long been a preferred way to move large flows of people at low levels of pollution and congestion per capita. Many promising mobility models now reflect an individualization of travel (Schwanen, 2016) with *apps* and *fleets* of cheap light electric vehicles and devices to move people as effectively at much lower costs.<sup>vi</sup> In the United-States, public transit ridership figures are already declining. Should cities forego massive infrastructure spending and repurpose roads and parking bays for new free-floating fleets? To what extent new technologies can replace complex transport infrastructures is unknown as no city has been able to reduce car ownership significantly enough to test the hypothesis.

Many changes in infrastructure development and management are under way, from integrated multimodal infrastructures (Ambrosino et al., 2003) to multirole infrastructures combining mobility and energy systems (Hautière et al., 2013; Cirimele et al., 2016, Crozet and Koning, 2019). Intelligent Transport Systems (ITS) are promising ways to review infrastructure pricing and favor clean transport (Harris et al., 2015; Cramton et al., 2018; Schuitema and Steg, 2018; Koning et al., 2019).<sup>vii</sup> Yet, the upscaling of such sets of solutions require multi-level urban governance systems which are missing. As of today, divided urban systems are commonplace, in lieu of harmoniously networked urban mangroves (Mangin, Girodo, 2016).

In Japan as well as in many other areas of the globe, the need for *quality infrastructures* (Runde, 2017, 2019; Nakamura et al., 2019) to respond to climate change mitigation and adaptation and meet with societies needs is much asserted. Yet, the obstacles on the way to sustainability have silently piled up: multilateral frameworks about climate, cities, development and growth, came up as deep transformations of the economy, the society, and the environment were already well on their way.<sup>viii</sup> This calls for a revised approach of infrastructure development.

What if UNECE became the cradle of a new generation of urban models, connecting the present review of transport, mobility and health issues with an update of the policy framework for sustainable real estate markets and a cross-sectoral approach of the implementation of the SDGs?

UN-Habitat proposes that “cities of the future should build a different type of urban structure and space, where city life thrives and the most common problems of current urbanization are addressed”. To realize this UN-Habitat proposes an approach that summarizes and refines existing sustainable urban planning theories to help build a new and sustainable relationship between urban dwellers and urban space, and to increase the value of urban land. This approach is based on 5 principles that support the 3 key features of sustainable neighbourhoods and cities: compact, integrated, connected.

Skilled spatial planners should have the ability to engage actors at all levels of development:

- Participation: engaging actors in reciprocal relationships of communications;
- Consultation: delivering expert advice for the purpose of drawing conclusions;
- Representation: acting on behalf of one or more groups of actors in an effort to represent both ideas and individuals;
- Appeal: acting as advocates for collective decision-making and for the improvement of the affected community.

Effective management is an essential factor defining the success or failure of spatial planning. Management is understood as organisation and coordination, policy and planning, and monitoring of relevant projects. The goals thereof extend to giving a hearing to opinions, analysis, decision-making and clarifying ideas that may have been misinterpreted.

Overarching goals of spatial planning

- To promote a system of meaningful and democratic governance that responds to the needs of local communities;
- To improve urban environmental performance;

- To facilitate social cohesion and security;
- To promote market reform in the housing and urban sector;
- To improve land and real estate markets and securing private rights in land.

Cities of the future should build a different type of urban structure and space, where city life thrives and the most common problems of current urbanization are addressed. UN-Habitat proposes an approach that summarizes and refines existing sustainable urban planning theories to help build a new and sustainable relationship between urban dwellers and urban space, and to increase the value of urban land. This approach is based on 5 principles that support the 3 key features of sustainable neighbourhoods and cities: compact, integrated, connected. UN-Habitat supports countries to develop urban planning methods and systems to address current urbanization challenges such as population growth, urban sprawl, poverty, inequality, pollution, congestion, as well as urban biodiversity, urban mobility and energy.

The Five Principles are<sup>16</sup>:

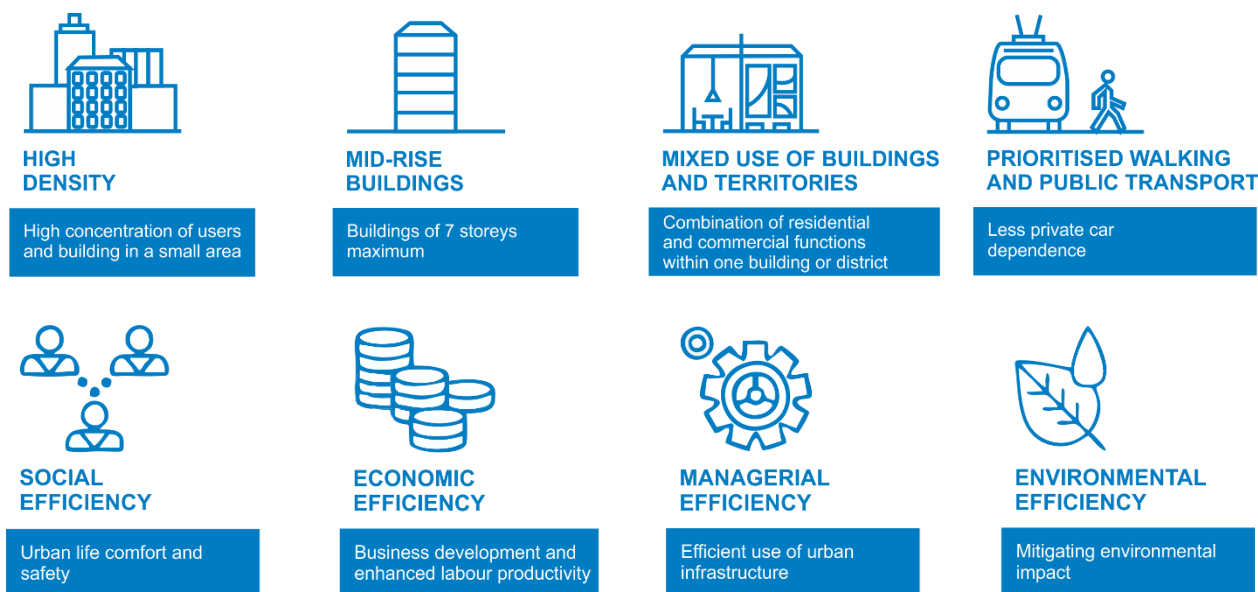
1. Adequate space for streets and an efficient street network. The street network should occupy at least 30 per cent of the land and at least 18 km of street length per kml.
2. High density. At least 15,000 people per kml, that is 150 people/ha or 61 people/acre.
3. Mixed land-use. At least 40 per cent of floor space should be allocated for economic use in any neighbourhood.
4. Social mix. The availability of houses in different price ranges and tenures in any given neighbourhood to accommodate different earnings; 20 to 50 per cent of the residential floor area should be for low cost housing; and each tenure type should be not more than 50 per cent of the total.
5. Limited land-use specialization. This is to limit single function blocks or neighbourhoods; single function blocks should cover less than 10 per cent of any neighbourhood. In recent decades, the landscape of cities has changed significantly because of rapid urban population growth. A major feature of fast growing cities is urban sprawl, which drives the occupation of large areas of land and is usually accompanied by many serious problems including inefficient land use, high car dependency, low density and high segregation of uses. Coupled with land use speculation, current models of city growth result in fragmented and inefficient urban space where urban advantage and city concept are lost.

The implementation of these principles has engendered the compact city concept. Key characteristics of a compact urban environment are shown in Figure 2.1. Compact urban environment is characterised by a combination of high-density development and a high-density street and road network while maintaining mid-rise buildings with buildings and territories sharing mixed use.

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<sup>16</sup> [https://unhabitat.org/wp-content/uploads/2014/05/5-Principles\\_web.pdf](https://unhabitat.org/wp-content/uploads/2014/05/5-Principles_web.pdf).

**Figure 2.3 – 2.4 Key characteristics of a compact urban environment (above) and a typology of theoretical benefits of compact cities from the perspective of social life, economy, governance and ecology (below)**<sup>17</sup>



High population density implies the generation of significant transport demand and a major load on transport infrastructure. In this context, the most effective solution is the use of public passenger transport. But the more users there are and the more diverse their requirements are to the quality of transport service, the more diverse the transport supply and the types of mobility used should be. In a compact urban environment with a highly dense street and road network, every mode of transport is given all the necessary conditions including walking and cycling.

As urban residents prefer to live, work, rest and do the shopping in a single particular area without wasting their time, money and effort on hours-long trips from one part of the city to another, a new trend for urban development has sprung up within the compact city concept (as one of its underpinning components) that is supposed to meet the diverse needs of citizens - “mixed-use development”, a trend interwoven with mixed-use development.

Mixed or multifunctional use is a concept of territorial development implying a variety of functions, social strata and ages within its confines.

The reach of potential places of attraction is substantially wider with a balance established between compactly placed facilities and the travelling speed of citizens<sup>18</sup>.

The term “mixed-use” implies a combination of at least three formats and three functions for a building: housing, commerce space and a business sector. This being the case, the commercial part of the building should be limited to just a few grocery stores, but should make up a large retail space that would accommodate dress departments, sports goods, pharmacies, cafes and restaurants. The key objective pursued by developers is to reduce the need for residents in the building to move around town as everything they need is located right outside the building.

Nowadays, the mixed-use concept is a popular trend among urbanists, as illustrated by the 5 Five UN-Habitat Sustainable Development Principles.

<sup>17</sup> Dileman F., Wegener M. Compact City and Urban Sprawl // Built Environment. 2004. Vol. 30, No. 4. P. 308 — 323.

<sup>18</sup> <http://strelka.com/ru/magazine/2017/09/20/mixed-use>, “Smeshannoye ispol'zovaniye - retsept sbalansirovannogo goroda” (“Mixed use - a recipe for a balanced city”.) Ksenia Bobrova, Architect-analyst, KB Strelka, 2018.



The objective of the land-use and development regulations is to minimise the harmful effects of the urban environment on human health. In line with this, zones with potential noise, vibrations, odours, excessive traffic and pedestrian flows should not be located near residential areas. Each zone is given a list of permitted types of use.

The fact that the land-use and development regulations limit the types of use for each territory helps the city authorities regulate the real estate market establishing favourable conditions for citizens.

Mixed use is characterised by a synergy effect: the proximity of sales outlets and services expands the clientele with shops exchanging their customers.

Different lifestyles can be also combined in territories of mixed use. Thanks to this, citizens do not need to leave the district that they have come to be so attached to as they get older nor to cut established social ties. Multifunctionality promotes the improvement of urban environment quality, thus driving up the value of real estate as well as boosting the incomes of the city and owners.

As home, work and shops are located close to each other in multifunctional areas, walking and cycling traffic goes up by 10% — 20%. Spending money on cars and public transport there is no longer a necessity for people which improves conditions for low-income citizens also effacing the boundaries of spatial segregation.

Compact blocks save time on trips which grants people more free time at the same time mitigating the environmental footprint. This way, the city capitalises on savings on environmental protection measures while the residents enjoy health benefits.

Being a natural path to urbanisation, the number and scale of urban agglomerations have been growing in Europe in recent decades. Currently, there are approximately 100 agglomerations with about 60% of the population of Europe living in them. Agglomerations are economic development hubs as well as being centres of social challenges and environmental burden. The development of new communication and transport systems coupled with better management mechanisms lead to the further expansion of agglomerations and the emergence of mega-urbanised areas.

Agglomeration development is associated with high demand for transport capacity, high infrastructure deterioration, environmental issues, the need for legal regulation of relations with municipalities included in an agglomeration. Agglomeration areas are also characterised by functional zoning (to fit housing construction, production, organisation of recreation areas (areas with recreational potential), etc.

## **2.2 Inclusive urban and transport planning, decision-making and strategy formulation**

### **2.2.1 Principles**

The quality of urban management is largely characterised by the quality of spatial planning, which, among other things, should ensure inclusiveness by striking a balance between urban accessibility and population mobility, taking into account the interests and capabilities of all categories of users as well as the impact of the transport system on the environment and health.

An effective urban policy aligned with multimodal transport solutions helps avoid irregular spatial development, provide a social and economic integration of different urban areas and population groups, and avoid environmental degradation.

The access to transport services is a critical factor in ensuring an inclusive urban environment, including:

- physical accessibility and barrier-free transport infrastructure, including, in particular, public passenger transport and non-motorised transport infrastructure (including for persons with reduced mobility);
- physical accessibility of motor vehicles (primarily public passenger transport) to all categories of users;
- affordability of public passenger transport services and new forms of urban mobility (taxi services, car sharing services);
- temporal accessibility of urban areas when using public passenger services

Accessibility is a key performance indicator of the quality of the urban transport system and public passenger transport services. In the latter case, the indicator of availability should be used both in shaping requirements for the route network and in defining requirements for the services of transport operators. Accessibility requirements are set out by a system of standards and rules (in particular, standards of public transport service, standards establishing requirements for infrastructure facilities, etc.).

Planning for inclusive urban transport systems involves building barrier-free multimodal transport chains for all categories of users of the correspondences in question.



**Figure 2.5** A park-and-ride near the centre of Munich (Bavaria, Germany). Area Vérdà new parking system in Barcelona (Catalunya, Spain), a regulated parking system divided into several areas. A checkpoint of the road toll system to access the central part of Stockholm (Sweden). A map of the Paris new bicycle plan

The inclusiveness of decision-making in the field of urban transport calls for wide involvement of different categories of users in discussions on the topic of relevant projects and programmes, specific solutions on transport provision of services to the population, public transport operational management and road traffic management.

It is important to learn from the many errors made at different times in different countries and avoid making them again. The worst error among all others was maybe the failure to adopt the principles of sustainable transport and urban planning and the lack of a systematic approach to intermodal transport planning.

Cities which endorsed the principles of sustainable urban and transport planning generally succeeded in becoming more liveable thanks to a combined package of measures which are directed on:

- Development and implementation of information and telecommunication technologies;
- Development of “electromobility”, “smart mobility”, shared mobility;
- Implementation of automated driving systems;

- The growth of public environmental awareness;
- Sharpening the focus on healthy lifestyles;
- Promoting changes in the transport behaviour of the population;
- Step-by-step implementation of the concepts “*Cities Are For People, Not For Cars*”, “*Smart city*”, “*Healthy Streets*”, “*Smart Mobility*” by city administrations.

The main goal of any effective strategy in the field of urban mobility is to satisfy the transport needs of both people and businesses in such a way that improves quality of life for the citizen and increases the competitiveness of a country or region.

The establishment of a visionary and well-grounded urban mobility strategy requires careful consideration of a number of dimensions (figure 2.6).

UITP has identified the system-level framework for sustainable urban mobility system (figure 2.7) which includes 4 elements:

1. Visionary Strategy and Ecosystem
2. Mobility Supply (solutions and lifestyles)
3. Mobility Demand Management
4. Public Transport Financing

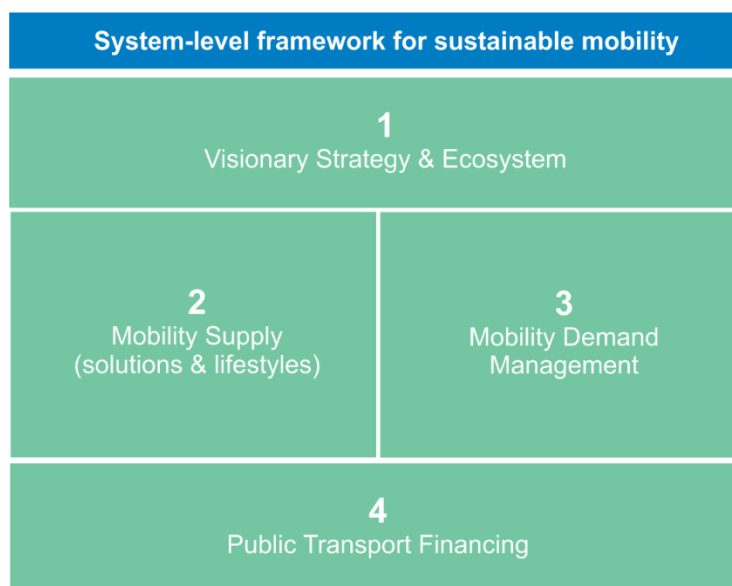
**Figure 2.6 Dimensions to be considered when defining a sustainable urban mobility strategy<sup>19</sup>**

<b>1 Sense of urgency</b>	<ul style="list-style-type: none"> <li>■ Understand patterns to reach shared understanding of mobility issues</li> <li>■ Objectivize current mobility performance &amp; gaps with best practices</li> </ul>	<b>Sensing the Scene</b>
<b>2 Accountabilities</b>	<ul style="list-style-type: none"> <li>■ Identify key stakeholders and clarify "grey zones" of accountabilities</li> <li>■ Understand current (public and private) mobility initiatives</li> </ul>	
<b>3 Stakeholders views</b>	<ul style="list-style-type: none"> <li>■ Understand needs and agendas of each stakeholder group</li> <li>■ Understand needs of different customer groups (individual, businesses)</li> </ul>	
<b>4 Scope</b>	<ul style="list-style-type: none"> <li>■ Define geographical scope: city, region, nation</li> <li>■ Define functional (mobility, sustainability) &amp; modal scope (persons, goods)</li> </ul>	<b>Vision &amp; Objectives</b>
<b>5 Vision &amp; Objectives</b>	<ul style="list-style-type: none"> <li>■ Develop a political vision and set priorities and targets</li> <li>■ Ensure alignment between stakeholders on priorities (non normative)</li> </ul>	<b>Strategy Formalization</b>
<b>6 Good practices</b>	<ul style="list-style-type: none"> <li>■ Synthesis of experience from other mobility strategies and initiatives</li> <li>■ Identify Good/Bad Practices and lessons learned</li> </ul>	
<b>7 Measures</b>	<ul style="list-style-type: none"> <li>■ Identify relevant mobility measures for set priorities and assess synergies</li> <li>■ Select strategic options in form of integrated package of measures</li> </ul>	<b>Strategy Execution &amp; Monitoring</b>
<b>8 Roadmap</b>	<ul style="list-style-type: none"> <li>■ Develop master plan with responsibilities and resources allocation</li> <li>■ Develop budget plan and synchronize with funding streams</li> </ul>	
<b>9 Governance &amp; Marketing</b>	<ul style="list-style-type: none"> <li>■ Set up clear governance mechanisms for monitoring and update</li> <li>■ Marketing of mobility strategy, PR work with other stakeholder groups</li> </ul>	

**Figure 2.7 System-level framework for sustainable urban mobility system<sup>20</sup>**

<sup>19</sup>[https://www.uitp.org/sites/default/files/members/140124%20Arthur%20D.%20Little%20%20UITP\\_Future%20of%20Urban%20Mobility%20%200\\_Full%20study.pdf](https://www.uitp.org/sites/default/files/members/140124%20Arthur%20D.%20Little%20%20UITP_Future%20of%20Urban%20Mobility%20%200_Full%20study.pdf), Arthur D. Little and International Association of Public Transport (UITP), The Future of Urban Mobility 2.0, 2014.

<sup>20</sup>[https://www.uitp.org/sites/default/files/members/140124%20Arthur%20D.%20Little%20%20UITP\\_Future%20of%20Urban%20Mobility%20%200\\_Full%20study.pdf](https://www.uitp.org/sites/default/files/members/140124%20Arthur%20D.%20Little%20%20UITP_Future%20of%20Urban%20Mobility%20%200_Full%20study.pdf), Arthur D. Little and International Association of Public Transport (UITP), The Future of Urban Mobility 2.0, 2014.



If an urban mobility policy based on implementing the above four elements is to succeed in achieving its aims, it is vital that all four elements are improved simultaneously as the overall results will be influenced by the performance of the weakest link. The relevance of the imperatives to each city will vary depending on the urban mobility city cluster to which they belong

Described below is the world's practice of successful combination of urban and transport planning together with a list of measures required to build and develop sustainable urban transport systems. The exact sequence in which to implement the measures recommended should be set out by each city on its own with due regard to existing constraints and available resources.

The purpose of a spatial strategy is to provide an overview of the proposed pattern of spatial development of the territory and to add value by coordinating the territorial impacts of industry policies. The critical issue for spatial strategies is how to maximize sustainable development through encouraging and guiding the spatial distribution of development, redevelopment and investment; the coordination of infrastructure, e.g. the transport, water, housing, health and social services that support such development; and also, the maintenance of environmental assets. The process of formulating a strategy should take into account the alternative spatial development options which are open to consultation and subject to strategic environmental assessment.

**Figure 2.8 A tentative list of 25 imperatives to be considered by cities as a basis for defining sustainable urban mobility policies<sup>21</sup>**

		Cities in emerging countries with partly underdeveloped mobility systems: "Develop Sustainable Core"	Cities with high maturity and low share of public transport, walking, cycling: "Rethink the System"	Cities with high maturity and high share of PT, walking, cycling: "Network the System"
Visionary Strategy and Ecosystem	Vision and objectives	Establish a transparent, viable and stable regulatory framework for PT, integrating national and regional mobility prerogatives and ensuring clear allocation of roles and responsibilities		
		Professionalize PTO and formalize public transport	Develop a political vision and urban mobility objectives based on strategic alignment between all key stakeholders	
	Strategy and master plan	Develop a visionary urban mobility strategy and master plan ensuring the right balance between stretch and achievability and shift focus from "supply oriented" to "demand oriented" measures		
	Integration of urban policies	Ensure coordination of transport planning with other policies	Develop an integrated approach for transport planning and other urban policies to shift from isolated decision-making toward integrated urban management	
	Level playing field	Initiate fair competition between modes and business models		
Mobility Supply (solutions & lifestyle)	Core PT offering	Invest to establish a sustainable mobility offering and do not replicate mistakes of developed cities	Develop competitive position of public transport by evolving from "transport provider" to "solution provider" via introduction of innovative business models and partnerships	
	Offering characteristics	Shift PTO culture from "fleet manager" mindset toward customer-centric culture and progressively enhance quality of public transport offering and customer experience		
	Value-Added Services	Further improve customer experience via service offering extension through partnerships and alliances with third parties		
	Integrated mobility	Encourage interoperability and develop multi-modal packages	Integrate the travel value chain via development of integrated mobility platforms	
Mobility Demand Management	Awareness creation	Engage with citizens and business community to encourage pragmatic, well-informed and sustainable travel and location choices		
	MDM measures to influence behavior of individuals	Introduce traffic calming measures to optimize streets usage conditions and increase quality of life for residents and businesses		
		Introduce pricing measures to steer mobility demand through financial incentives and better synchronize supply and demand		
	MDM measures to influence behavior of businesses	Introduce and enforce parking policy as a critical instrument to steer mobility choices, while gradually increasing sophistication of fee and regulation structure		
		Define appropriate land-use policies to influence long-term mobility patterns and encourage transit-oriented development	Encourage businesses to develop active corporate mobility strategy to improve mobility of individuals and goods while minimizing costs	
Public Transport Financing	Fare revenue	Drive demand for public transport to maximize fare revenue by focusing on gradual increase of service offering quality and ensure transparency of fare adjustments		
		Further individualize mobility offering by providing bundles of services targeting different customer groups at different prices		
	Additional revenues	Assess opportunities to exploit PT assets to derive additional revenues through aggregation of third party services		
	Public funding	Prioritize public funding for capital investments into projects with sound business cases demonstrating policy benefits and long term viability		
	Earmarked charges	Explore opportunities to perceive charges from indirect beneficiaries of PT and earmark them for PT financing		
Private funding	Further stimulate partnerships with private investors while focusing on preserving business model solidity over short term funding opportunities			



## 2.2.2 Sustainable Urban Mobility Plans (SUMP) and other strategic transport planning documents

A Sustainable Urban Mobility Plan (SUMP) – a strategic plan designed to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life - can play a big role in this regard. The development and implementation of Sustainable Urban Mobility Plans is fundamentally different from traditional transport planning (Figure 2.9). The full planning cycle of the SUMP encompasses four primary phases (Figure 2.10):

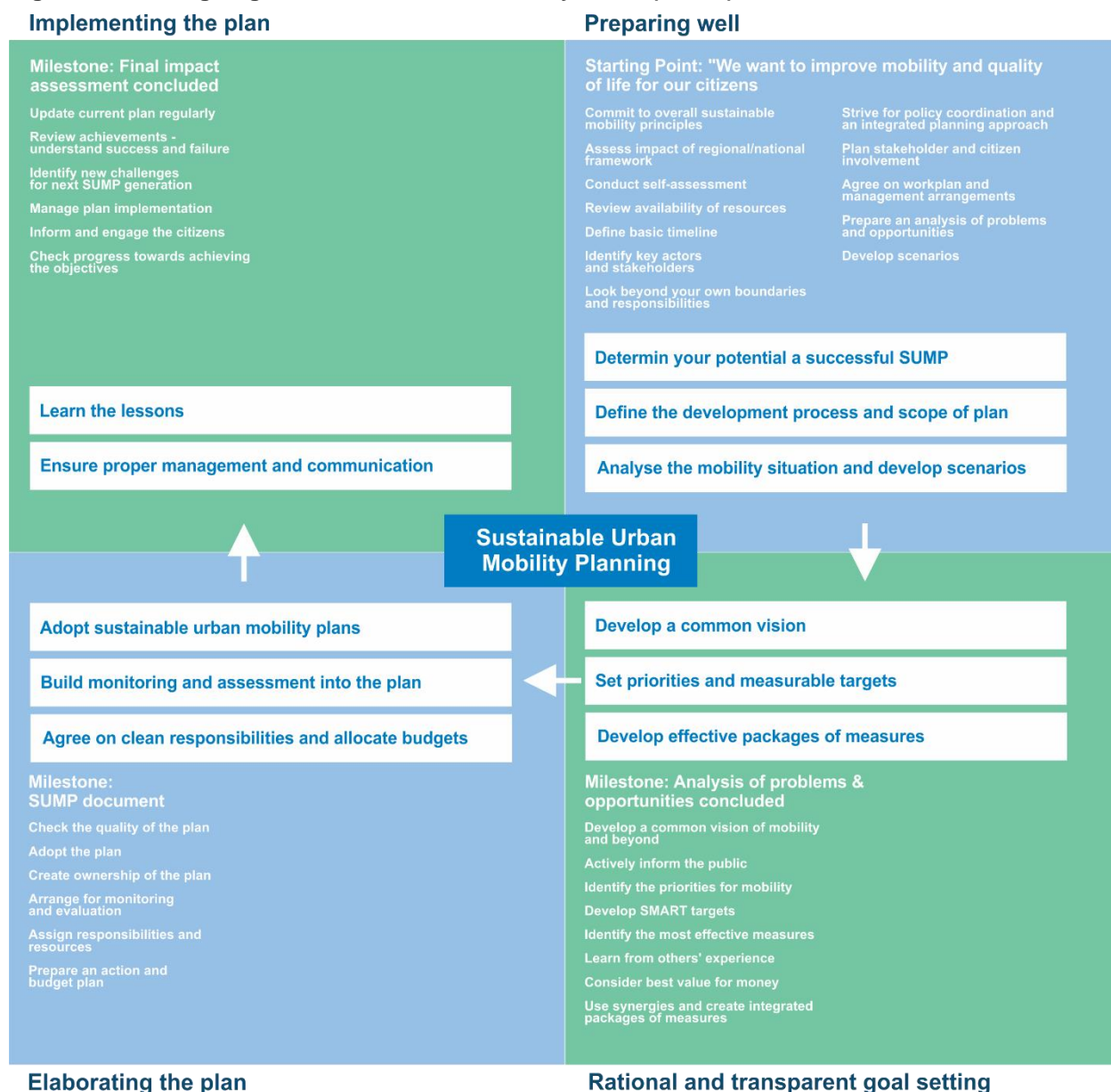
- Meticulous preparation of the planning process (“Preparing”)
- Transparent and rational goal-setting (“Goal-setting”)
- Development of the plan (“Elaborating”)
- Fulfilment of the plan. (“Implementing”)

**Figure 2.9. Differences between traditional transport planning and sustainable urban mobility planning**

Traditional transport planning	Development and implementation of a Sustainable Urban Mobility Plan
Focus on traffic flows	Focus on people
Main objectives: capacity of the road network to handle traffic flows and their speed	Main objectives: accessibility and quality of life, economic development, social equality, human health and environmental safety
Focus on the form, not the content	Balanced development of all modes of transport with a shift towards more environmentally friendly and sustainable modes of travel
Main focus on transport infrastructure	Integrated range of actions required to achieve effective solutions. Special emphasis on urban planning and urban planning solutions
Planning for each area separately pursuant to legal instruments in force	Plans are integrated and interlinked with each other and with legal instruments in force (transport and urban planning, improvement of public spaces, safety, etc.)
Short-term and medium-term plans	Short-term and medium-term plans are part of a long-term vision or strategy
Planning with experts involved in the process	Planning with the engagement of stakeholders in the process through a transparent and participatory approach, etc.

<sup>21</sup>[https://www.uitp.org/sites/default/files/members/140124%20Arthur%20D.%20Little%20&%20UITP\\_Future%20of%20Urban%20Mobility%202%200\\_Full%20study.pdf](https://www.uitp.org/sites/default/files/members/140124%20Arthur%20D.%20Little%20&%20UITP_Future%20of%20Urban%20Mobility%202%200_Full%20study.pdf), Arthur D. Little and International Association of Public Transport (UITP), The Future of Urban Mobility 2.0, 2014.

Figure 2.10. Designing Sustainable Urban Mobility Plans (SUMP)<sup>22</sup>



The SUMP principles developed by ELTISplus incorporate 11 steps and 31 actions (clarification of specific objectives). The steps and actions form a logical rather than a step-by-step sequence. The process is a cycle of actions that take place partly in parallel. The cycle serves as the basic structure for the development and harmonisation of the SUMP. The final actions involve an evaluation of the process and the result in order to find the best solutions in the next SUMP<sup>23</sup>.

The implementation of SUMP meets several types of barriers:

- Difficulties in collaboration between different authorities and lack of political consciousness;

<sup>22</sup>[http://www.eltis.org/sites/default/files/guidelines-developing-and-implementing-a-sump\\_final\\_web\\_jan2014b.pdf](http://www.eltis.org/sites/default/files/guidelines-developing-and-implementing-a-sump_final_web_jan2014b.pdf) "Guidelines. Developing and Implementing a Sustainable Urban Mobility Plan, The Poly-SUMP Methodology", The European Commission, ELTISplus, European Platform on Sustainable Urban Mobility Plans, EACI/IEE/2009/05/S12.558822, 2014.

<sup>23</sup>[http://www.eltis.org/sites/default/files/guidelines-developing-and-implementing-a-sump\\_final\\_web\\_jan2014b.pdf](http://www.eltis.org/sites/default/files/guidelines-developing-and-implementing-a-sump_final_web_jan2014b.pdf) Guidelines. Developing and Implementing a Sustainable Urban Mobility Plan, The European Commission, ELTISplus, EACI/IEE/2009/05/S12 .558822, 2014

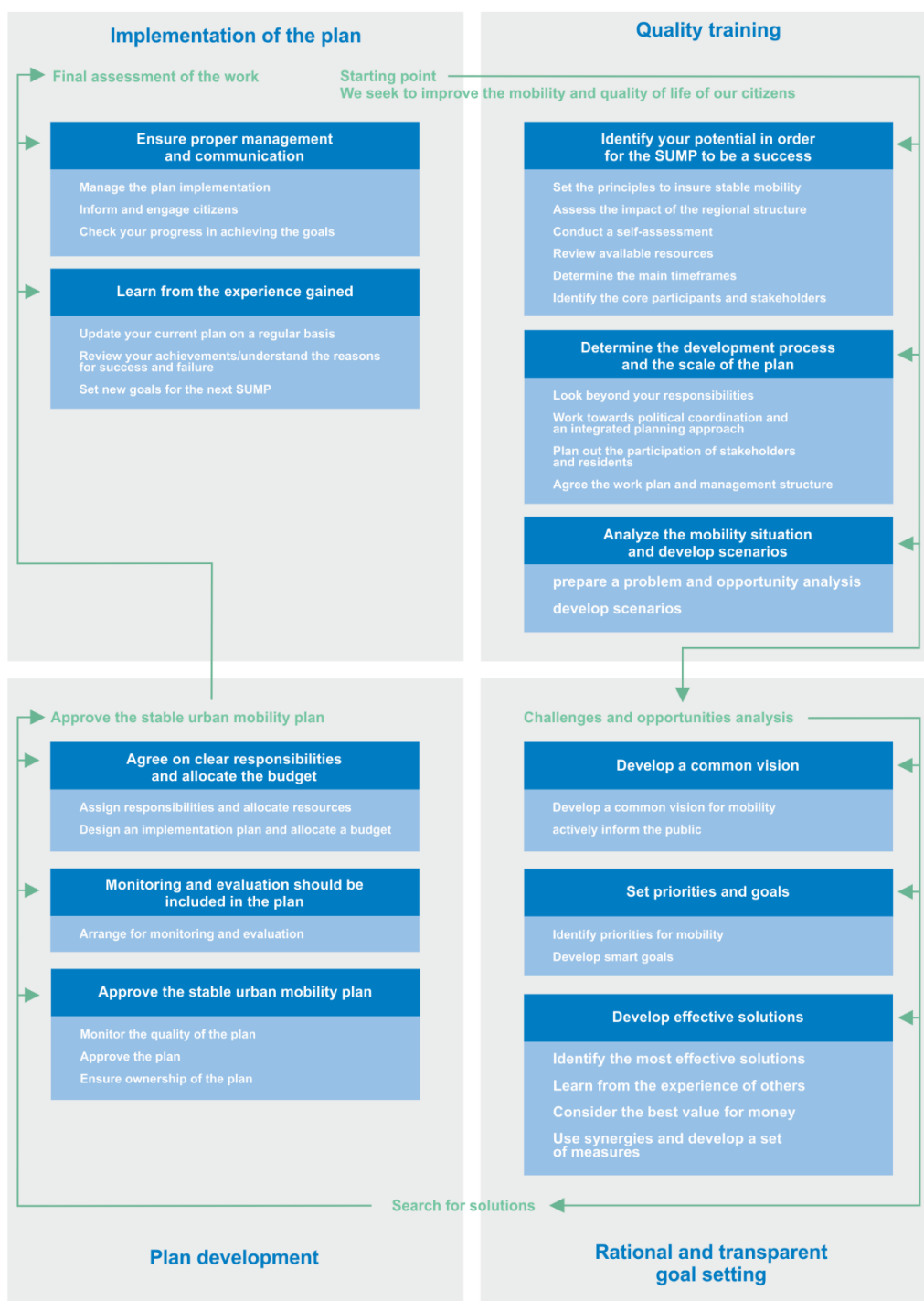
- Weak collaboration between the areas of activity, i.e. transport, urban development and land-use;
- Insufficient funding and limited budgets of cities;
- Lack of experience in developing options;
- Inadequate public support;
- Lack of experience in attracting investors;
- Lack of information and data on how new programmes, technologies, etc. are applied.

The algorithm of action to develop a sustainable urban mobility plan is presented at **Figure 2.11.**

**Figure 2.11. The algorithm of action to develop a Sustainable Urban Mobility Plan**



### Stable urban mobility planning SUMP



In the last decade, the EU members adopted a Green Paper *Towards a new culture for urban mobility* (2007), alongside with the *Leipzig Charter on Sustainable European Cities* (2007). In 2015, they adopted the *European agenda for urban mobility to the Paris Agreement* as well as a new *Urban Agenda* based upon 12 priorities, including mobility. In the meanwhile, based upon a *White Paper Roadmap to a Single European Transport Area* in 2011, the European Commission adopted a series of 40 concrete initiatives to increase mobility and build

competitive transport systems. In 2013, the *Urban Mobility Package* was adopted, recognizing the responsibility of local level stakeholders to promote sustainable urban mobility<sup>24</sup>.

The Sustainable Urban Mobility Plans (SUMP) were introduced as part of the implementation of the 2013 Urban Mobility Package, which highlights the connected responsibilities of EU, national and local government levels in fostering innovation and change. The Mobility Package also exemplifies, as the 2015 new Urban Agenda, how urban mobility does relate to other major policies, such as energy, air quality, economy, social equity and accessibility.

A Sustainable Urban Mobility Plan has as its central goal improving accessibility of urban areas and providing high-quality and sustainable mobility and transport to, through and within the urban area. It regards the needs of the 'functioning city' and its hinterland rather than a municipal administrative region.

The European Commission supports the promotion and further development of the concept of Sustainable Urban Mobility Plans (SUMP), as well as the provision of the necessary tools and guidance to assist cities across Europe with the implementation of their mobility plan. Core SUMP principles are presented at figure 2.12.

SUMPs are not only a technical tool, among many others. As the 6th European Conference on SUMP is taking place in the Netherlands in Groningen in June 2019, SUMP serve as common platforms for policy makers, local authorities, urban transport planners, academics, NGOs and other mobility professionals.

Since their launch in 2013 and according to the European urban mobility observatory Eltis, "the SUMP guidelines have become the main reference for the development of Sustainable Urban Mobility Plans and have been adopted widely across Europe".

**As of 2019, the SUMP Guidelines are being updated to reflect recent trends in mobility, technology and society. This is the right time to actively encourage a triple helix kind of approach to sustainable urban mobility and transport, connecting multilevel governance, urban policies and transportation policies, and the industry.**

Figure 2.12. Core SUMP principles

<b>Core SUMP principles</b>
1. Meeting the basic mobility needs of all users
2. Balancing and responding to the diverse demands for mobility and transport services by citizens, businesses and industry
3. Guiding a balanced development and better integration of the different transport modes;
4. Meeting the requirements of sustainability, balancing the need for economic viability, social equity, health and environmental quality
5. Optimizing efficiency and cost effectiveness
6. Making better use of urban space and of existing transport infrastructure and services
7. Enhancing the attractiveness of the urban environment, quality of life, and public health
8. Improving traffic safety and security
9. Reducing air and noise pollution, greenhouse gas emissions, and energy consumption
10. Contributing to a better overall performance of the trans-European transport network and the Europe's transport system as a whole

<sup>24</sup> Source: *European Urban Mobility. Policy Context*. European Commission, March 2017

As was mentioned earlier in Guidelines “Developing and Implementing a Sustainable Urban Mobility Plan” developed by European Platform on Sustainable Urban Mobility Plans<sup>25</sup> these documents have to foster a balanced development of all relevant transport modes, while encouraging a shift towards more sustainable modes. The plan puts forward an integrated set of technical, infrastructure, policy-based, and soft measures to improve performance and cost-effectiveness with regard to the declared goal and specific objectives.

The following topics would typically be addressed:

(a) Public transport: Sustainable Urban Mobility Plan should provide a strategy to enhance the quality, security, integration and accessibility of public transport services, covering infrastructure, rolling stock, and services.

(b) Non-motorised transport: Sustainable Urban Mobility Plan should incorporate a plan to raise attractiveness, safety and security of walking and cycling. Existing infrastructure should be assessed and improved where necessary. The development of new infrastructure should be envisaged not only along the itineraries of motorised transport. Dedicated infrastructure should be considered for cyclists and pedestrians to separate them from heavy motorised traffic and to reduce travel distances, where appropriate. Infrastructure measures should be complemented by other technical, as well as policy-based, and soft measures.

(c) Inter-modality: A Sustainable Urban Mobility Plan should contribute to a better integration of the different modes and should identify measures aimed specifically at facilitating seamless and multi-modal mobility and transport.

(d) Urban road safety: A Sustainable Urban Mobility Plan should present actions to improve road safety based on an analysis of the main road safety problems and risk areas in the concerned urban area.

(e) Road transport (flowing and stationary): For the road network and motorised transport, a Sustainable Urban Mobility Plan should address moving and stationary traffic. Measures should aim at optimising the use of existing road infrastructure and improving the situation in the identified 'hot-spots' and overall. The potential for reallocating road space to other modes of transport or other public functions and use which are not related to transport should be explored.

(f) Urban logistics: A Sustainable Urban Mobility Plan should present measures to improve the efficiency of urban logistics, including urban freight delivery, while reducing related externalities like emissions of GHG, pollutants and noise.

(g.) Mobility management: A Sustainable Urban Mobility Plan should include actions to foster a change towards more sustainable mobility patterns. Citizens, employers, schools, and other relevant actors should be engaged.

(h) Intelligent Transport Systems: ITS being applicable to all transport modes and mobility services, both for passengers and freight, they can support strategy formulation, policy implementation and monitoring of each of the measures designed under the framework of a Sustainable Urban Mobility Plan.

Basel (Switzerland) drafted and approved a Sustainable Urban Mobility Plan (SUMP) in 2015. It finished among the 3 finalists of the 7<sup>th</sup> SUMP Awards which were announced in March 2019, ranking 2<sup>nd</sup> behind Manchester, which was praised for its multimodality approach.

The Basel SUMP (Verkehrspolitisches Leitbild) includes fundamental measures for the next 10 to 15 years. The SUMP has its basis in the cantonal constitution and has four overriding goals:

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<sup>25</sup> [http://www.eltis.org/sites/default/files/sump\\_guidelines\\_en.pdf](http://www.eltis.org/sites/default/files/sump_guidelines_en.pdf), Guidelines “Developing and Implementing a Sustainable Urban Mobility Plan”, European Platform on Sustainable Urban Mobility Plans, 2014.

1. Increase quality of life and liveability;
2. Further improve accessibility;
3. Increase safety and minimize risk of accidents;
4. Ensure cost-effectiveness.

Starting from these four overriding goals, seven strategic areas have been defined:

1. Improve infrastructure for active travel modes
2. Enlarge public transport offers, especially cross-border
3. Reduce road traffic and channel it onto the highways
4. Improve parking management
5. Impact travel needs and patterns through mobility management
6. Improve public street space and allow short paths
7. Improve the sustainability of urban freight traffic

For each of these strategic areas, specific goals, strategies and measures have then been developed and documented in the SUMP. In 2018, the implemented measures have been checked for efficiency, progress has been monitored and the initial measures have been adapted and extended where necessary. At the same time, new measures and projects have been defined for the next three years.

**Figure 2.13 Inner-city and regional connectivity are at the heart of Basel Sustainable Urban Mobility Plan (SUMP)**



Basel SUMP is therefore in different phases at the same time: measures are being implemented and monitored and new ones are being planned and elaborated while the targets are, in some cases, being adapted based on new developments and technologies.

Many positive results have already been obtained by implementing measures from the SUMP in the first three years.

Some examples include the slight reduction of car traffic on urban streets in spite of the current population and economic growth in the canton Basel-Stadt, very good results in surveys concerning perceived quality of life of the inhabitants of the canton and the very high accessibility that characterizes the region, especially with public transport. A significant increase in the number of cyclists, the noticeable improvement of road safety and air quality, moreover, are further proof that the plan has been effective from the start. Furthermore, the possibility to adapt and define the specific goals every three years allows to also consider new technological developments and trends and to incorporate these in the plan of action, in order to keep up with the time. It is expected that, by continuing to follow the SUMP and implementing the measures defined in it, the targets will be met accordingly and the results will benefit not

only the inhabitants of the canton Basel-Stadt but also the surrounding region with the French city of Saint-Louis and the German city of Lörrachand

Basel SUMP exemplifies not only the city scale but also regional and cross-border cooperation for more sustainability<sup>26</sup>.

The expected effects/impacts of sustainable urban and transport planning strategies can be both local (a reduction in air pollution as well as in the accident rate and transport noise) and global (a reduction in greenhouse gas emissions) and benefit both the population (improved health, lower premature mortality, better quality of life) and territories (enhanced accessibility, enabling conditions for development).

Also, it is very important for city administrations to develop programs for the integrated development of transport infrastructure. Proposals for the development of transport infrastructure should cover all modes of transport.

The main principles of these programs are the following:

- safety, quality and efficiency of transport services for the population, as well as legal entities and individual entrepreneurs, engaged in economic activities in the territory of a settlement or urban district;
- availability of transport infrastructure facilities for the population and subjects of economic activity in accordance with the standards of urban planning of a settlement or the standards of urban planning of a city district;
- development of transport infrastructure in accordance with the needs of the population in the mobility or legal entities and individual entrepreneurs, engaged in economic activities - in the transportation of passengers and cargo;
- development of transport infrastructure balanced with urban development;
- managing transport demand;
- priority conditions for ensuring the safety of life and health of road users in relation to the economic imperatives of business activities;
- priority conditions for the movement of public transport;
- development of walking and cycling;
- efficient functioning of the existing transport infrastructure.

Various types of transport planning documents (Master plans, Integrated Road Traffic Management Schemes, Programs of Transport Infrastructure Development etc), are called to solve the following tasks:

- ensuring transport and pedestrian connectivity of territories including proposals for the development of a regional and municipal network, aimed at reducing the off-target load on federal roads, needed for the maintenance of local communications;
- organization of rational distribution of transport flows including transit, along the network of roads with the use of reverse and one-way traffic, if necessary, as well as by improving the information support for drivers;
- traffic light regulation and implementation of an automated traffic control systems;
- the organization of the public transport movement, especially on dedicated lanes;
- formation of a single parking space of the city and, if necessary, paid parking space;
- development of bicycle and pedestrian traffic and appropriate safe infrastructure allowing to relieve a significant load from the road network;

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<sup>26</sup> Based on the answers given by Basel (Switzerland) to the UNECE questionnaire.



- ensuring road safety, etc.

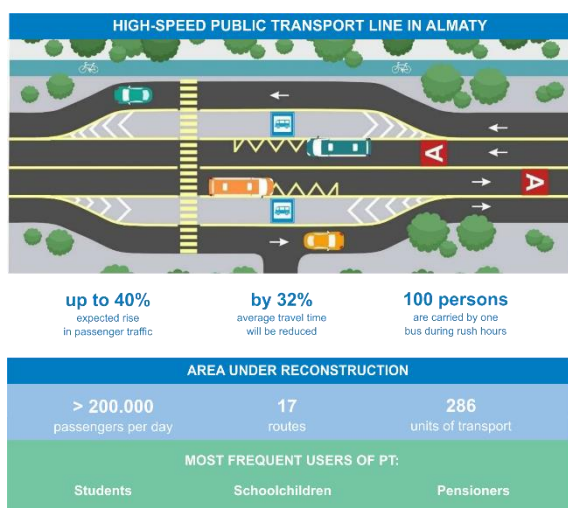


**Figure 2.14 A comprehensive plan for sustainable mobility and transport in Almaty (Kazakhstan)**

In Kazakhstan, the city of Almaty has engaged since 2013 in a Strategy of sustainable transport with technical support from the *United Nations Development Programme - Global Environment Facility “Sustainable Transport in Almaty”*. Among the main drivers of change, the development of high-speed corridors for public transport as well as the development of infrastructure for non-motorised traffic were put forward.

A new street format was proposed and designed which has a green corridor combining the unconditional priority of public transport with bicycle and pedestrian infrastructure in one of the busiest streets in Almaty.

The project for the first Bus Rapid Transit (BRT) line designed in 2015-2016 builds on transport modelling and passenger flows estimation data. The pilot area of pedestrian space reconstruction with a segregated bicycle arranged was completed in 2016.



**Figure 2.15 A comprehensive plan for sustainable mobility and transport in Almaty (Kazakhstan): development of a BRT network**

The first section of the high-speed bus corridor - the BRT line with a length of 8.7 km (out of 22.4 km) was finished in 2018 now servicing 26 routes with a traffic of more than 140.000 passengers daily. Both buses and trolleybuses operate within this corridor. Its main section stands out due to the axial location of dedicated lanes for public transport, which gives it an inarguable advantage over private vehicles.

The experience of Almaty is unique, as it has managed to avoid the need for construction of overpasses for stations owing to the open-type

BRT. There are the following advantages: saved surrounding space, minimum station-to-sidewalk distance, accessibility for people with reduced mobility; passengers have become able to gather on and leave stop platforms quickly with the height of the platform allowing for unhindered boarding or disembarking from low-floor public transport vehicles for people with reduced mobility. The reduction in travel time for public transport users is more than 20%. In December 2018, new articulated 18-metre buses were put into service and electronic timetables were put in place. The year 2018 was also marked by a mass replacement of rolling stock in bus fleets with Euro-2-3 buses replaced with Euro-5 ones.

Altogether, in 2018, over 100 km of dedicated lanes for public transport and more than 80 km of cycling paths were commissioned, an urban bike rental system was put in place and mass cycling events were held to promote sustainable types of movement around the city. The city is progressing towards driving out private cars with a view to curb emissions from motor vehicles<sup>27</sup>.

<sup>27</sup> Based on the information provided by the Mayor's Office of Almaty (Kazakhstan) and the UNDP-GEF Project "Sustainable Transport of Almaty", 2018, <https://alatransit.kz/ru>

**In the Russian Federation, the legal and regulatory framework establishing requirements to the project documentation on transport planning is created<sup>28</sup>.**

The Town Planning Code of the Russian Federation provides for the obligation of city administrations to develop Programs of Integrated Development of Transport Infrastructure. The requirements for these programs are approved by the Resolution of the Government of the Russian Federation No. 1440. In the framework of these Programs existing and long-term distribution of passenger flows by modes of transport is provided taking into account issues of accessibility and quality of transport services, environmental and health impacts of transport.

Federal Law No. 443 «On Traffic Management in the Russian Federation» establishes the legal procedures and order for development of documentation on traffic management at local (Traffic Management Projects) and network (Complex Schemes of Traffic Management) levels to ensure quality and safety of traffic. Priority for public transport is one from the key requirements for realization of traffic management schemes.

Federal law No. 220 «On the Organization of Regular Passenger and Luggage Transportation by Road and Electric Public Transport in the Russian Federation and on Amendments to the Certain Legislative Acts of the Russian Federation» in particular provides the base for public transport systems planning.

All these documents generally make it possible to create the legal base for ensuring of sustainable developing transport system.

One from the elements of transport planning in the Russian Federation is implementation of restrictions on access of vehicles with low environmental performances on some urban territories. The legal base for such solutions was created<sup>29</sup> according to Article 30 of the Federal law No. 257 of 8th November 2007 «On Roads and Road Activities in the Russian Federation and on Amendments to the certain legislative acts of the Russian Federation» and to Article 6 of the Federal law No. 96 of 4th May 1999 «On protection of ambient air». In accordance with these documents the state authorities can ensure the protection of air quality in residential areas. and restriction of motor vehicle`s access. In 2017, the new terms of «electric car» and «hybrid car» were defined and relevant traffic signs and markings were introduced in the Traffic Code of the Russian Federation (by the resolution of the Government of the Russian Federation No. 832 of 12th July 2017). The same resolution introduced new road sign «Zone with the restriction of trucks` traffic by the ecological class» and additional information signs «Ecological class of vehicle».

These solutions provide an opportunity for public authorities and local governments as well as for road owners to impose a ban on transit through the territory of settlements of vehicles with low environmental performances in order to reduce the negative environmental and health impact and to provide preferences for “clean” transport modes and vehicles.

Advanced and efficient modelling techniques are required to forecast the outcomes of urban and transport development Strategies, SUMP, results of implementation of separate tools, measures and solutions, to identify ways to improve these tools, measures, Plans and Strategies as a whole and pick out the most effective scenarios.

There are different types of models which may be used:

- Traditional network and transport planning models that disregard the effects of land use;
- Policy research models that furnish a simplified view of a city and help users grasp the kind of outcomes that a policy can bring around;

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<sup>28</sup> Provided by the Ministry of Transport of the Russian Federation, 2019.

<sup>29</sup> Provided by the Ministry of Transport of the Russian Federation, 2019.

- Sketch planning models, which give a representation of the key relations between demand, supply and land use at the strategic level in a city without detailing transport networks or the nature of land use;
- Transport and urban planning models are Land Use and Transport Integrated models (LUTI), which help get a clear understanding of transport networks and land-use patterns and their interrelation with the focus on strategic issues. This model is the most complex one structure-wise.

The land-use and transport model can help get a notion of how people's transport behaviour will shift in response to changes in the transport system; the way in which the efficiency of the system will respond to changes in the nature of its use; how the situation with traffic congestion, pollution, accidents, public mobility will change, etc.; how shifts in land-use will affect the use of the transport system and how changes in the cost of using the transport system will affect land use.

In practice, it is well-advised to combine mathematical modelling for predicting quantitative indicators with qualitative approaches to estimate those indicators that cannot be quantified (e.g. "quality of life").

The use of these complex models has proven to require sufficient resources and expertise. To some extent, this serves as a barrier to their use.

When developing an effective urban planning system and implementing it in a specific urban context, the following three key aspects must be focused on:

- Communities and local organisations engaged in specific urban development activities as well as addressing existing urban development challenges;
- Stakeholders whose activities, interests, needs and values are directly dependent on urban development issues;
- Platforms for stakeholders and partner organisations to engage between each other.

The involvement of all stakeholders requires mutual efforts to be made in a harmonious and constructive manner. These activities should involve national and local authorities, transport and health sectors, environmental protection, urban planning authorities, business structures and civil society. Both vertical integration (from the top level of ministries to grass-roots structures and communities, civil society organisations that play a pivotal part in sustainable development policies, ensuring access to environmental information and awareness-raising) and horizontal integration are required; the latter involving a coordinated strategic approach across all four sectors — transport, health, environment and urban development.

The required horizontal integration can be achieved institutionally via combining the functions of the respective authorities (e.g. by creating a single authority for land use, transport and environmental protection), or through establishing special interdepartmental administrative bodies (commissions, committees, etc.) led by the heads of city administrations. The objectives and goals related to environmental protection and health are vital to decision-making mechanisms in the transport and land-use sectors and therefore should be integrated into these mechanisms. That kind of integration should be achieved at a level equivalent in importance to the direct goals and objectives of these sectors. Beyond that, quantitative indicators to measure the progress of these goals and associated tasks must be defined along with necessary monitoring and evaluation mechanisms and mechanisms to present claims in environmental protection and public health (expertise, monitoring, etc.).

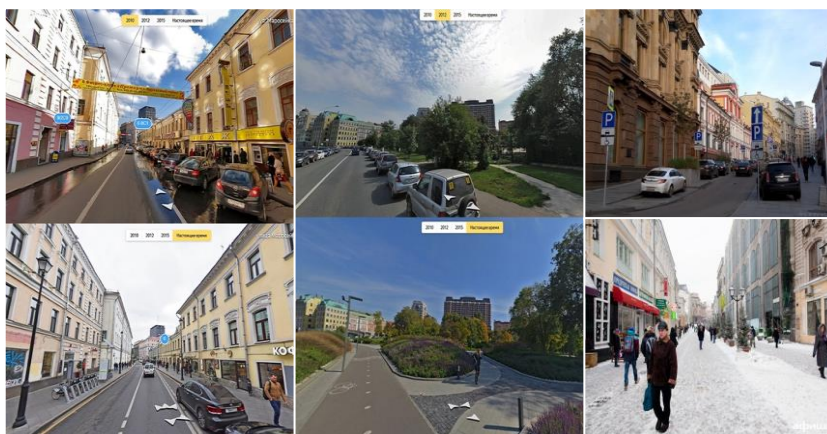
As far as the population is concerned, it needs to understand and assimilate the objectives of urban policies in order for their transport behaviour to be changed. Therefore, information and awareness-raising campaigns, especially in relation to aspects of transport demand regulation and mobility implementation models, are strategically important for building public support. In that regard, significant success can be achieved through:



- continuous communication with local and municipal authorities with surveys and policy evaluations published to ensure transparency in decision-making.
- making full use of local and national health systems to highlight the health impacts and other beneficial aspects of transport policies.
- launching mass public information campaigns to tout the benefits of active mobility as a practical, healthy and safe alternative to the use of private vehicles. Raising awareness among parents and children about the benefits of walking and cycling, urging them to practice active mobility through demonstration activities.
- collaboration with the media and NGOs to promote walking and cycling, PT use and to generate a favourable image of public transport; to promote car-sharing, car-pooling, park-&-ride spaces (P+R), bike sharing through public events and wide coverage of all propitious environmental, economic and social effects. Popularising physically active modes of travel brings down the injury rate as motorists gradually adapt to the presence of pedestrians and cyclists on the road who must be traffic users with equal rights.

The expected effects/impacts of sustainable urban and transport planning strategies can be both local (a reduction in air pollution as well as in the accident rate and transport noise) and global (a reduction in greenhouse gas emissions) and benefit both the population (improved health, lower premature mortality, better quality of life) and territories (enhanced accessibility, enabling conditions for development).

### 2.2.3 Sustainability, mobility, accessibility



**Figure 2.16** Examples of street space transformation in central Moscow: Maroseika street (left) and Crimean embankment (center), Kuznetzky Bridge (right)

The effective alignment between transport and urban planning, results-orientation, formulating "Cities for People" strategies and (political, financial, legal,

communication, marketing) tools to implement them has a pivotal part to play in ensuring accessibility.

Shifting urban and transport planning from mobility planning to planning accessibility and quality place making yields results in the form of the creation of the best urban communes, improving the environment and the state of the urban economy while enhancing the physical activity of citizens. However, planning practices remain too often an obstacle for accessibility policies, especially due to indirect incentives for urban sprawl.

**Figure 2.17 Summarizing Accessibility issues**

Challenges		
Lack of implementation	Conceptual ambiguity	
	What accessibility?	How much accessibility?
Usability limitations of accessibility measures	Ill conception	Identifying accessibility needs
Usefulness limitations of accessibility measures	Lack of appropriation	Defining sufficient accessibility
Insubstantial role of accessibility in the policy agenda	Low adherence to real-life concerns	Standardisation
	Partial implementation	Loss of meaning of accessibility
		Appropriateness to context of use

In view of the above, it is of vital importance to act and take measures in order to plan and manage accessibility in the context of ensuring sustainable urban development.

For instance, in 2010 in Basel, Switzerland, as a consequence of a referendum held in the canton Basel-Stadt (Switzerland), a

quantitative reduction goal for cars was incorporated into the Environmental Protection Act (Umweltschutzgesetz USG). It was thereby established that a 10% reduction of the traffic flow of privately owned cars, from the level of 2010, has to be achieved by 2020.

This target has been chosen because traffic in the canton Basel-Stadt is highly influenced by international commuters and visitors, which makes it difficult to determine a modal split for these categories. In addition, the modal split alone is not enough to fully determine the sustainability of an urban mobility system. The canton Basel-Stadt wants to focus more on the quantity of trips and the length of these trips, while also taking into account growth effects: the quantitative goal aforementioned states that the number of cars has to be reduced by 10% in spite and no matter how high the population growth will be. This target, however, is not a mere ideological one, the idea is to promote and to favour vehicles and transport modes with low emissions and low energy consumption that are space-efficient, also very important in city dense with narrow streets<sup>30</sup>.

**Lyon (France): putting accessibility at the heart of city life<sup>31</sup>**

Many cities across the European Union are working hard to create liveable cities that are accessible to all – regardless of age, mobility or ability. The city of Lyon in France has chosen to address accessibility as a cross-cutting issue and to invest substantially in creating a barrier-free and inclusive environment.

Promoting independent mobility is an important part of Lyon’s overall strategy to become more accessible. This is particularly important considering that 30 % of the people who use Lyon’s public transport network are affected by mobility issues. This includes people with ‘permanently reduced’ mobility (wheelchair users, people with visual impairments and those who are deaf or hard-of-hearing, etc.) and ‘temporarily reduced’ mobility (pregnant women, and people with pushchairs, shopping or luggage, etc.).

Urban mobility and public transport are important focal points in the ‘Accessibility Programme’ of the city of Lyon. The Programme has been developed by a Communal Accessibility Commission that consists of elected representatives from the city and its nine boroughs, and representatives from 62 civil society organisations and institutional partners. Besides mobility, the Programme targets the accessibility of public space and municipal institutions, and overall accessibility of life in the city (e.g. culture, education, employment and information).

Specific improvements in urban mobility are planned and guided at the level of the at the Métropole de Lyon (also known as Greater Lyon) level. Metropolitan Lyon was created in 2015 as territorial authority to coordinate the development and implementation of policies in the 59

<sup>30</sup> Based on the answers given by Basel (Switzerland) to the UNECE questionnaire.

<sup>31</sup> <http://www.eltis.org/discover/case-studies/lyon-putting-accessibility-heart-city-life>, Michiel Modijefsky, 2019.

municipalities that make up Greater Lyon. On behalf of Metropolitan Lyon, SYTRAL is the sole organising authority of urban and intercity transport in Greater Lyon and in the larger department of Rhône Department.

The extensive and accessible transport network covering Lyon and the greater Metropolitan area is the result of 30 years of continuous planning by SYTRAL, public authorities in the metropole, transport operators and other partners. In 1997, Lyon was the first in France to adopt a Sustainable Urban Mobility Plan (in French; Plans de déplacements urbains abbreviated to 'PDU') after 2 years of analysis and consultation. The 1997 PDU was revised and updated in 2005 and in 2015 work began on the current PDU (2017 to 2030), which was established in 2017. With each version, the geographical scope of the PDU was adapted in order to respond to the dynamics of the Lyon agglomeration and mobility patterns of its population. As such, the 2017 PDU covers the territory of 73 municipalities: the Métropole de Lyon, the 8 communes of the Community of Communes East Lyonnais (CEEL) and the 6 communes of the west Lyon for which SYTRAL acts as transport authority.

The PDUs are considered to be examples of a well-integrated planning approach, where the various objectives and measures identified are synergetic. For example, the current PDU (2017 to 2030) includes 122 actions along eight strategic axes. One of these is promoting access to mobility for all. At the same time, actions under other strategic axes also contribute to improving access to mobility, for example by promoting:

- the organisation of public space around soft/active modes (e.g. walking);
- high quality and service levels for public transport throughout the metropolitan Lyon;
- integrated land-use planning, with mixed land use to keep distances to services acceptable and maintain appropriate population density to support public transport services.

In addition to the PDU, actions to improve access to mobility and the transport network have been guided by the Accessibility Master Plan (in French: Schéma Directeur d'Accessibilité, abbreviated SDA) and the Programmed Accessibility Agenda (in French: Schéma Directeur d'Accessibilité - Agenda d'Accessibilité Programmée, abbreviated SD'AP). These voluntary policy instruments were introduced in France in 2005 and 2015 respectively, specifically to improve the accessibility of the roads and public spaces as well as the public transport network.

A budget of EUR 60 million was allocated to carry out all operations to meet this objective. This ambitious programme for the TCL network – which consists of metro, tram, bus, trolleybus and two funiculars – has been implemented by SYTRAL between 2008 and 2015.

The public transport network is extensive, including four metro lines, two funicular lines, five tram lines, 1 000 buses and 6 555 stops. All of the vehicles used for public transport are equipped with a low floor, retractable ramps and wider entrance doors, while each has four seats reserved for people with reduced mobility.

All metro stations (except Croix-Paquet where the configuration does not allow its redevelopment) are now accessible. They are equipped with sound-system lifts and embossed buttons and braille to enable easy access for people with low or no vision, as well as people in wheelchairs. Seven out of 10 bus stops are equipped for people with reduced mobility. Lyon's approach is in many ways an example of an integrated planning and needs-based approach. Both principles are captured in the underlying objectives of the consecutive PDUs:

The organisation of travel must be in line with the development of the agglomeration, including the economy and its companies, with the aim of facilitating the use of the right mode of travel in the right place.

Users and their needs should be at the heart of planning process.

Mobility planning should promote social equity and improve access to different mobility services.

Mobility planning should improve air quality and the quality of the overall environment.

The development of an Accessibility Master Plan also reflects both the high level of user participation and the horizontal and vertical integration of mobility and accessibility planning into wider policy.

Even with smaller investment budgets to promote accessibility, the integrated and participatory way in which accessibility has been addressed in Lyon provides a useful example of how to effectively promote accessibility.

## **2.3 Reviewing planning strategies in “hypermobile” societies**

### **2.3.1 Towards the end of car-centric urban models?**

Nowadays, it is absolutely clear that the policy of adapting cities to cars is no effective remedy for congestion, because sooner or later there will be no room for all. With mass motorisation, the failings of inadequate urban transport planning cannot be swept under the rug”.

The analysis of the situation dominant in most cities in developed and developing countries indicates a number of causes:

1. In most cities, urban transport is seen as a whole neither functionally nor spatially.
2. Spatial planning often has no connection to transport planning: the impact of new developments and land - use changes on road traffic is rarely assessed.
3. Financial resources allocated in cities for urban transport are often inadequate, erratic in nature and do not undergo strategic planning.
4. The lack of statutory requirements or recommendations. Cities have no obligation to design strategic plans for sustainable urban transport systems or sustainable urban mobility plans and secure room for them in the urban budget.
5. Weak institutional and technical potential in various functional areas, such as:
  - Traffic management in many cities is narrowly defined and poorly technically implemented: (a) There are no strategic plans with a special focus on these issues. Consequently, cities rarely take road engineering measures to improve pedestrian safety and prioritise public transport (b); Intelligent Transport Systems (ITS) lack wide implementation in traffic organisation and monitoring as well as in passenger information; (c) traffic light systems are obsolete in many cities.
  - Efforts aimed at investments in high-speed passenger transport systems (metro, LRT, BRT, city trains) and integration of different modes of transport (in terms of route planning, real-time passenger information, single ticket introduction, fare collection systems and timetables) need to be stepped up considerably. In some cities, the metros are very short and often poorly integrated with other modes of public transport; operating costs account for the lion's share of cities' budgets.
  - Management of the demand for privately owned vehicles by pursuing alternative measures (development of public transport, park and rides, car sharing, carpooling, non - motorised types of travel) along with implementing various transport policies to restrict trips by privately owned vehicles in congested parts of cities.
  - Tram tracks and lines being dismantled, transferred and closed, urban electric transport providers folding and going bankrupt.
6. The different types of urban passenger transport are poorly interconnected both with each other and with cycling and walking traffic; their potential still untapped or not capitalised upon.
7. Limited investments in innovative technologies that could improve traffic management and make travel more comfortable and safer for passengers.

### **Urban spatial planning is a long-term action tool with its effect likely to be felt in decades.**

Areas of mixed land use and with a well-developed network of internal streets and driveways are characterised by shorter distances and a shift in the proportion of travel to non-motorised (walking and cycling) types of travel. By contrast, separate land use and the prevalence of high-speed motorways increase in the number and length of road trips.

Urban planning measures themselves are not very effective due to the conservativeness of human behaviour, so they must be complemented by *carrot* and *stick* measures aimed at overcoming conservativeness. However, a well-organised land-use structure is an essential element in the effective implementation of other measures targeted at discouraging excessive mobility. In view of the close link between urban planning and mobility, much more attention should be paid to analyses of planned activities/projects from the perspective of their potential impact on the generation of transport demand. If increasing transport demand cannot be averted, possible alternatives involving public and non - motorised transport should be examined.

The establishment of an enabling environment for a particular type of travel improves its attractiveness for potential users, thereby paving the way for the “induced transport demand” effect<sup>32</sup>. In other words, “*demand begets supply, and supply begets demand.*”

### **2.3.2 Fighting induced transport demand**

Induced transport demand is an extra peak transport demand derived from the expansion and improvement of road infrastructure. It is divided into “diverted trips” (shift of vehicle traffic by time and/or route) and “induced trips” (increase in average annual vehicle mileage).

Statistics indicate that as the network of high-speed roads expands, so do both the speed and length of trips therefore the time spent on daily trips remains effectively constant. As a result, traffic congestion turns into a “balancing” factor: growing traffic congestion results in restrictions on peak - hour trips.

While expanding the road network initially reduces congestion, it ultimately results in induced traffic, which keeps growing until congestion increases again decelerating it. In consequence, the assumption that the combat against congestion leads to time saved for motorists is not justified. Also unjustified is the assertion that increased mobility of motorists brings them additional benefits as in the instance of induced demand, motorists chiefly take trips “*out of necessity*” which they would not mind avoiding. Due to the “induced transport demand” phenomenon, investments in transport infrastructure may lead to higher overall demand for travel. Enhancing the capacity of available roads or building new ones are popular ways to overpass congestion. However, experience has shown that such measures do not reduce the level of congestion in the long - term.

Normally, it takes induced transport demand a few years to virtually offset the effect of expanding transport infrastructure. In the majority of cases, expanding the road network diminishes its overall efficiency while driving up the “external” transport costs and contributing to the car dependency of the population. On the contrary, the deployment of a public passenger transport system (PPT) is gradually gaining in efficiency by attracting more users.

In this regard, measures to contain “hypermobility” should therefore be taken; these covering a wide range of administrative, economic and information measures directed, in the first instance, at minimising the negative effects of “hypermotorisation”.

#### **Solutions to limit “hypermobility” or “mobility sprawl”:**

(a) Organisational: • restriction of vehicle ownership; • restriction of access for vehicles to a certain area; • design of transport plans (for enterprises, schools, residential areas and

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<sup>32</sup> S.V. Shelmakov, Ekotransport (Eco-transport): textbook / S.V. Shelmakov — M.: MADI, 2018. 199 p.



regions), as well as personal transport planning; • home-based work; • online commerce with home delivery; • information and marketing campaigns.

b) economic: • rising the cost of vehicle ownership; • rising the cost of vehicle use; • parking fees. c) infrastructure-related: • optimization of the transport information network; • redistribution of street space for the benefit of pedestrians, cyclists and public transport, • “calming” traffic; restriction of parking spaces; • landscape street design.

The list of transport policies aimed at improving traffic conditions and preventing chronic congestion on the road network always goes hand in hand with demand constraints and, therefore, should incorporate:

- use of modern traffic management techniques to make the most effective use of the available resources of the street and road network;
- reconstruction of intersections in one level, which are bottlenecks in terms of the capacity of the street and road network as a whole;
- organisation of one-way traffic on all sections of the network which will enhance the capacity;
- introduction of strict parking rules, especially in the streets, where parked cars result in a deterioration of their capacity;
- placing public transport at an advantage in traffic, including by virtue of allocating designated lanes and ensuring a priority green phase at crossings in one level;
- introduction of hourly parking fees with fees significantly higher for long parking hours, especially in the city centre;
- implementation of regulations to encourage car owners to acquire a parking spot at their place of residence;
- introduction of speed and through-traffic restrictions in the streets in residential areas;
- introduction of shared use and speed-limited traffic;
- introduction of fees for using certain sections of the street and road network. For instance, a fee to drive into the city centre.

In Basel (Switzerland) forecast for urban public transport demand is made with a high resolution multi modal transportation model, which considers public transport, motorized individual transport, bicycle and pedestrians as well. Park & Ride and Bike & Ride are also displayed in the model. The model perimeter includes the Swiss, German and French part of the Basel metropolitan area<sup>33</sup>.

### 2.3.3 Case studies and good practices

**The Green Mobility initiative**, supported between 2013-2017 by the Nordic Council of Ministers (Copenhagen) which is being carried into effect by ICSEER “Leontief Centre” (based in St. Petersburg) represents a unique strategic platform which pursues the goal of developing sustainable mobility in Russian cities and regions by relying on the best international and Russian practices in delivering effective transport policies and sustainable development of transport systems. The partnership network encompassed by the Initiative involves more than 150 Russian and international experts on sustainable territorial development. The Green Mobility Award Ceremony is held annually to highlight the best examples of sustainable mobility development in Russia and abroad. The award goes annually to cities where innovative projects and strategies aimed at the development of transport sustainable modes are put into action, the mobility of all citizens is being enhanced, greenhouse gases and pollutants in the atmosphere are dwindling with safety improving and an accessible environment for pedestrians and cyclists is being established.

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<sup>33</sup> Based on the answers given by Basel (Switzerland) to the UNECE questionnaire.

**Fig. 2.18 Kazan (Tatarstan Republic, Russian Federation) is moving towards an integrated approach of transport and mobility**



In Kazan (Republic of Tatarstan, Russian Federation), the city seeks to curb down congestion with measures to optimise traffic (traffic signalisation, re-marking roadways), to address the demand-side management of trips by private motorised transport (paid parking, calm traffic zones), to redistribute traffic flows (one-way traffic) and to create new transport links (construction of new roads, overpasses, junctions).

The shaping of a sustainable urban transport system in Kazan rests on 10

principles:

1. Safety of passengers on the general-use public urban passenger transport routes;
2. Ensuring equal access to transport services for all areas and social groups of people;
3. Ensuring comfort for passengers using public urban passenger transport;
4. Ensuring the accessibility of public urban passenger transport for persons with reduced mobility;
5. Prioritising urban passenger transport over private vehicles;
6. Optimal combination of different types of public passenger transport;
7. Reducing time spent on passenger traffic;
8. Reducing economic costs associated with the maintenance of public urban passenger transport;
9. Curbing emissions of greenhouse gases and pollutants that come from the use of vehicles;
10. Streamlining the route network with its coverage area extended<sup>34</sup>.

The current Code of Rules SP 42.13330.2016 “*Urban development. Urban and rural planning and development*” serves as the mechanism that links transport planning and urban planning. It is aimed at providing urban planning means to ensure security and sustainability in the development of municipalities, local design requirements for urban development and cohesion for strategic planning documents. The Master Plan of Kazan acts as a document of strategic planning which determines the direction to be taken in urban development. It is comprised of units of urban prospective development, transport system prospective development and indicators of promising socio-economic development. Besides, the development of urban transport systems is incorporated into transport planning documents; the programme for integrated development of transport systems and the road traffic management integrated scheme serving as these planning documents. Urban planning and transport policies are interlinked while transport planning documents are in the pipeline. That helps track the transport accessibility of new districts while also preventing any shortage in transport services.

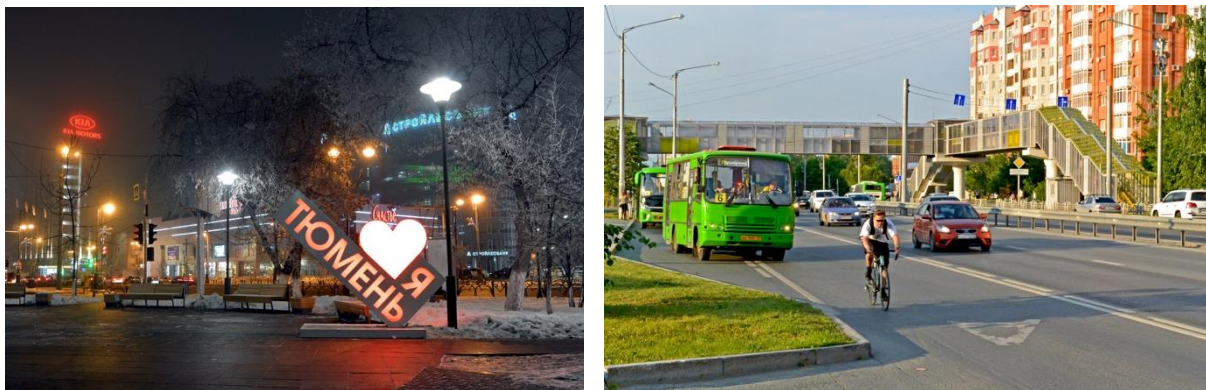
The use of public transport in Kazan is incentivised in two key areas: direct incentives to promote the use of public transport (establishing enabling conditions for fast, comfortable and safe traffic by dedicated lanes, ensured priority of travel, easy transfers, single tickets sold for all types of transport) and discouragement of private vehicle trips (introduction of speed limits as well tolled parking space).

Demand for urban passenger transport services in Kazan is forecast through a software system that is based on PTV mathematical transport modelling by using data obtained through sociological surveys and surveys of traffic conditions. Now, an up-to-date and relevant transport model has been developed for the Kazan agglomeration.

<sup>34</sup> Based on the answers given by Kazan (Russia) to the UNECE questionnaire.

In order to manage transport demand within the city, Kazan utilises advanced domestic and foreign practices, including a single parking space (including tolled parking space), efforts to develop the network and improve the quality of public transport service. In the short term, calmed traffic areas will be introduced. Examples of these measures are given in the Integrated Road Traffic Management Scheme and the Integrated Transport Scheme until 2033<sup>35</sup>.

**Fig. 2.19 A transportation plan for 2040 in Tyumen (Russian Federation)**



In Tyumen, the city administration approved a transport infrastructure integrated development programme for Tyumen for the period 2018 - 2040. Pursuant to the programme, the planned spatial development of the city is aimed at the intensive transformation of the urban environment, the consolidation of available buildings, the establishment of sustainable linkages between the existing network of streets and the emerging ring system of high-speed traffic arteries.

The planning structure of Tyumen builds upon natural and anthropogenic frameworks. The natural framework of the city rests upon the bed of the Tura River and a range of green areas made up by parks, squares, boulevards. The master plan of the city district of Tyumen involves the preservation of these areas with a focus on developing their recreational function.

The anthropogenic framework of the city of Tyumen covers the main lines of engineering infrastructure networks and roads that ensure internal and external transport links.

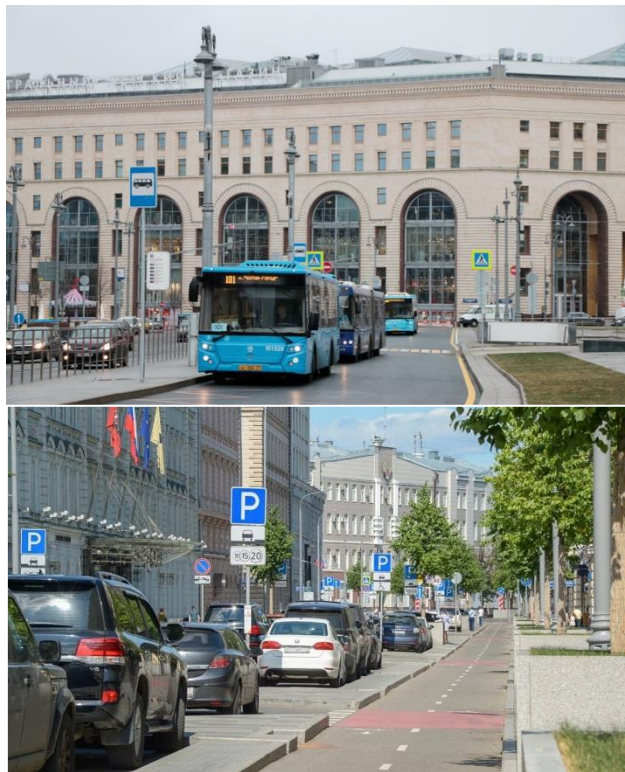
The resolutions set forth in the Master Plan of the city district of Tyumen provide for a functional saturation of the public city centre; strengthening its representational and socio-cultural functions. It is this part of the city of Tyumen that is undergoing the most intense reconstruction and re-development achieved through residential districts becoming denser, greening and improvements taking place, multi-level outdoor parking space and pedestrian streets being put in place and multifunctional complexes being constructed.

A planned increase in the density of buildings invariably gives rise to the need to change the properties and the capacity of motorways. Given the current structure of urban streets, it is only possible to ensure a projected increase in transport correspondence provided that the private vehicle usage rate is reduced in favour of public municipal passenger transport, walking and cycling<sup>36</sup>.

<sup>35</sup> Based on the answers given by Kazan (Russia) to the UNECE questionnaire.

<sup>36</sup> Based on the answers given by Tyumen (Russia) to the UNECE questionnaire.

**Figure 2.20 Dedicated lanes for public transport and cycling in Moscow (Russia)**



In 2011, Moscow City Hall drafted and implemented a strategy for the development of Moscow transport until 2020 in cooperation with the academic and expert community and by relying on the best world practices in the field of transport and road transport infrastructure and by assessing in advance the extent of their applicability to Moscow.

The main components of Moscow new transport system, which is currently under development are based upon

Improved convenience: modernisation of the rolling stock, development of passenger information systems, implementation of intermodal ticket and tariff solutions, increase of urban transport capacities, development of barrier free infrastructure for citizens with reduced mobility, “*My street*”, a programme for reconstruction and improvement of the street and road network, etc.

Increased availability: extension and integration of the metro, Moscow Central Circle and suburban railway lines, development of city taxi and short-term car rental, construction of new and rehabilitation of previously dismantled tram lines; construction of Park-and-Rides to serve as transport hubs; organisation of a single parking system, construction of new roads and road junctions, development of the urban transport network of routes, development of alternative modes of transport, etc.

Increased speed: construction of new metro lines coupled with the Moscow Central Circle and suburban railway lines, introduction of dedicated lines for urban transport, separate tram lines, optimised timetables and reduced waiting time achieved through shorter intervals introduced for urban public transport, integration of the Intelligent Transport System (ITS) and the Integrated Road Traffic Management Scheme (KSODD), etc.

The route network of Moscow responds flexibly to shifts in transport demand. State Institution (GBU) “MosTransProject” is the organisation in charge of determining whether routes should be altered and the financial and operational indicators of operating routes re-calculated. Whenever required, changes into the route network are introduced in the shortest time possible with the necessary time taken to properly inform the public.

Demand forecasting is carried out by macromodelling. In the process, the transport model used includes information on the entire road infrastructure: roads, marking, public transport routes, which helps determine the capacity and congestion of roads, the route network efficiency, as well as predict the behaviour of the transport system in a given scenario.

In essence, this model is a platform for experiments to be conducted upon, which helps foresee the effects of any innovation. As for Moscow, this transport model was created in 2012 and went on to become the key tool used for decision-making, for instance, when planning routes, overlaps, setting up traffic lights and other activities<sup>37</sup>.

<sup>37</sup> According to the response of Moscow (Russia) to the UNECE questionnaire.



**Figure 2.21 Sustainable mobility in the innovation district of Skolkovo (Moscow, Russian Federation)**

Skolkovo is more than just a science city or a tech park as it represents a full-fledged city with colourful architecture and unique opportunities for engagement, a city which incarnates advanced solutions targeted at establishing an attractive urban environment, one comfortable for visitors and citizens to the fullest extent. Skolkovo has a population of 19,500 people (2017).



The concept of Skolkovo incorporates the dreams of an architect, an ecologist and a futurist engineer all at the same time featuring ingenious architectural solutions and electric transport which embody of the vision of a city of the future. Urban development innovations designed and fulfilled here are free to be adopted by any municipality in the world.

The principles of sustainable mobility lie at the heart of transport management infrastructure in Skolkovo. Pursuant to the Transport Strategy of the Skolkovo Innovation Centre, only electric cars have clearance to drive into the city while ride-and-park parking lots, much like a membrane, limit entry to those visitors who arrive in private cars propelled by internal combustion engines. Special emphasis is placed on the development of unmanned vehicles; the city having a special track intended for testing out innovative vehicles.

The Skolkovo transport system is oriented on pedestrians, cyclists and electric modes of transport. These are no empty statements as the city is vigorously expanding its infrastructure to accommodate sustainable modes of transport. The first electric buses were put into trial operation in the city back in 2016. The city is developing short electric bus routes useful for putting new models to the test. In June 2017, an ultra-fast charging station was launched.

Infrastructure for sustainable transport modes in Skolkovo:

- Separate cycling paths - 50 km
- Urban bike rental service - 8 stations
- Scooter rental service - 12 stations
- Electric vehicle charging stations - 29 stations

The city intends to have all “last mile” transport vehicles transition to electric traction by launching rental services of e-bikes, e-scooters and e-vehicle carsharing.

Skolkovo's experience is unique. There is no city in Russia that has thus far abandoned private motor vehicles in favour of eco-friendly transport modes in so resolute a manner nor has any Russian managed to plan out a transport system predicated so competently on the principles of sustainable mobility. Skolkovo is indeed a city of the future, whose transport solutions should be studied by other Russian cities<sup>38</sup>.

<sup>38</sup> According to the Green Mobility initiative, supported between 2013-2017 by the Nordic Council of Ministers (Copenhagen) which is being carried into effect by ICSEER Leontief Centre (based in St.-Petersburg), [www.mobility.leontief-centre.ru](http://www.mobility.leontief-centre.ru).



**Figure 2.22 An integrated Urban Transport plan in Strasbourg (France)**

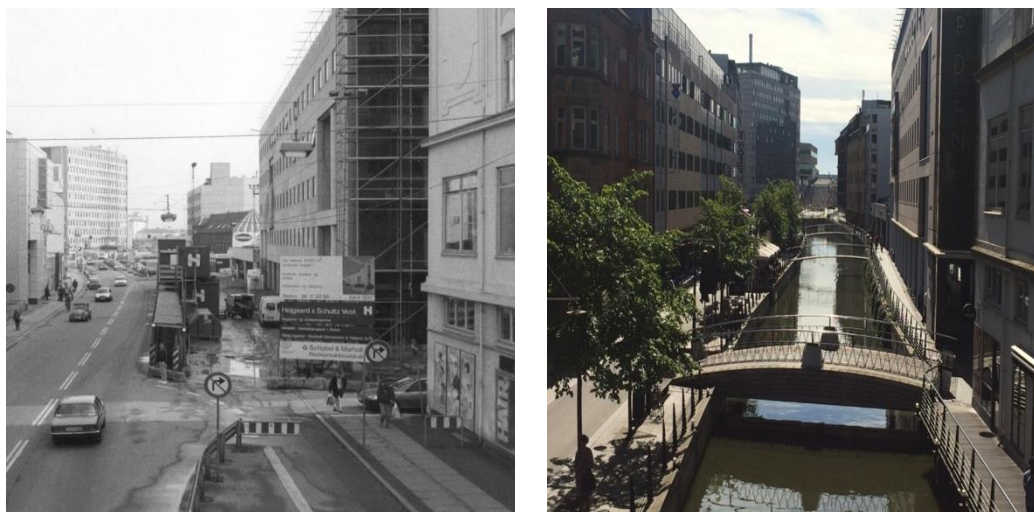
in Strasbourg (France), the 5 years Urban Transport Plan in Strasbourg was adopted after a participatory process which brought together key players. Twelve workshops were set up, three of which were integrated into the “travel and public health” themed group, which was chaired by the city councillor in charge of health. These workshops focused on the promotion of active modes of travel, transport and pollution, and travel for people with reduced mobility.



The Strasbourg Urban Transport Plan aims to increase physical activity by encouraging promoting active mobility through:

- improving the communication of travel times on foot and by bike;
- implementing multimodal exchange centres favouring the use of modes of transport other than private cars;
- implementing a pedestrian plan in Strasbourg;
- building new, and improving existing, cycle paths;
- increasing awareness of the health benefits of active mobility<sup>39</sup>.

**Figure. 2.23 A long history of developing a livable city of Aarhus (Denmark)**



At the same time, Aarhus should be CO<sub>2</sub>-neutral by 2030. This places heavy demands on the ambitious urban development in which the Department of Urban Development and Mobility plays a central role.

Like other large European cities, Aarhus is seeing a restructuring period. Run-down industrial estates are disappearing to be replaced by housing and knowledge-intensive businesses. A number of areas in Aarhus are currently undergoing major changes: large parts of the port area are being converted into residential, knowledge-based business, cultural and educational buildings. The disused rail freight terminal will in future house Aarhus School of Architecture and other educational institutions together with youth-/student housing. Today Godsbanen is the driver of the area, a cultural production centre, including performing arts, visual arts and literature, focusing on youth culture.

<sup>39</sup> Based on the answers given by Strasbourg (France) to the UNECE questionnaire.

Aarhus has the lowest average age of the country and does its best to keep youth from moving to Copenhagen. Aarhus believes culture can change the world and the status of the European Capital of Culture 2017 proves it. Aarhus has been preparing to it for at least 25 years. Investing in the university with its 60 thousand students makes Aarhus the youngest city in Denmark, and as a result of investments in social architecture (restructuring the port area and creating social centers like Godsbanen where all they can create, meet, design), in music and theater (the Musikhuset was built in the 80s and enlarged in 2007), more and more people choose Aarhus as a place to live for its cultural life.

Changing from a major town to the city causes mobility challenges. It gets cheaper to drive a car, and if there are no changes to the mobility patterns 20 000 cars will have been added by 2030. This is a challenge, since the road network at certain times of the day already suffers from congestion. Add weak public transport and parking problems in the inner city.

To prevent the consequences and solve the challenges, the City of Aarhus has developed a policy vision focused on growth, livability, health, sustainability, densification. Here are policy's goals and initiatives:

Goals:

- No growth in car traffic over the inner Ring;
- Traffic growth as biking, walking and public transport;
- Increase travel speed for bicycles;
- A greener and more livable city.

Main initiatives:

- A road network leading to central parking facilities;
- Improve conditions for active and public modes;
- Peaceful residential areas;
- Parking policy;
- Easier shift between modes – a mobility system;
- Flexible streets.

In the Municipal Development Strategy (2016), Smart Growth has high priority. Following the strategy, the city should grow denser in the future, moving travel destinations closer to each other and making the public transport system more efficient. The smart choice of mobility is an important part of the Municipal Development Strategy, supported by infrastructure projects, such as the almost completed light rail and super commuter bike paths. The transition to more public transport is one of the preconditions for reaching the ambitious climate goals.

The new Downtown Mobility Plan (2017) for the City of Aarhus replaced the existing Downtown Traffic Plan from 2005. The main objective of the existing traffic plan has been to rearrange the hierarchy of roadways. This was done to redirect much of the traffic going through the downtown area out on the surrounding ring roads in order to connect the city better with its redeveloping waterfront. The main objective of the Downtown Mobility Plan is to build on this hierarchy to accommodate a denser and more livable downtown area. This means a more space-efficient mobility system, where rising mobility needs are primarily to be met through a focus on active and public travel modes as well as reduced commuting distances.

The Downtown Mobility Plan is intended to convert surface parking and road space to squares or green spaces where possible. To reach that goal the City of Aarhus employs a variety of soft and hard measures that can be crudely split into three categories. First, access to the strategic road network will be removed for selected residential streets while existing bidirectional streets are converted to one-way streets with a single lane. This will improve traffic flows on the strategic network and encourage local residents to consider alternatives to the car. Meanwhile, the leftover road space can be used for cycle lanes, bus priority lanes, wider sidewalks or green spaces. Second, local businesses, citizens and interest groups in busy downtown areas will get the option of using on-street parking for non-parking purposes at

selected times such as during summer, on weekends or after office hours. This will favour active and public travel modes to these destinations due as well as allow more outdoor seating or green spaces through parklets or other temporary installations. Third, the existing parking restrictions for the city core will be expanded to cover the entire downtown area as well as the surrounding neighborhoods. Since visitors will have to pay for parking, this will free up more on-street parking spaces for residents while making active and public travel options a more sensible option for long-distance commuters. Furthermore, the parking revenues can be used to construct underground parking facilities that will further free up surface area for a more livable public realm<sup>40</sup>.

Since 2018 the transport department of Tbilisi City Hall has been participating in the urban planning process at the municipal level, guided by the relevant resolutions regarding the city planning and construction regulation. In the case of constructions or the change in the functional zone and etc., the transport impact assessment is prepared. Additionally, approving a Land use masterplan is soon to be expected. The masterplan deals with the issues of land use and the politics of city planning – factors that will facilitate the development of effective and sustainable mobility and, more generally, the compact city in order to reduce the dependency on the private cars and avoid urban sprawl<sup>41</sup>.

## 2.4 Urban traffic management: preventing congestion

### 2.4.1 Passenger traffic

Growing urban population leads to an increase demand for urban routes but their extensive development no longer meets all the mobility needs of society and economy.

Tackling these issues takes a close interconnection between decisions taken in the field of urban planning, road construction, public transport infrastructure development, road traffic management and information support for transport. However, it is important to be mindful of the need to take into account the environmental and social factors of decision-making.

Studies of urban transport systems substantially differ in both approaches and conclusions. Still, all researchers concur that with the use of private vehicles growing in an unrestrained manner, traditional and well-established cities cease to be comfortable for life, i.e., they all recognise collision that occurs between cars and cities as an objective reality.

Typical reasons behind the deteriorating situation with road traffic in cities are:

- growing public motorisation;
- use of private vehicles climbing in intensity;
- decreased proportion of public transport in passenger traffic;
- growing demand for movement among urban dwellers;
- disproportion between the level of motorisation and the pace of road construction;
- a number of objective urban planning problems related to urban spatial development inherited from the past<sup>42</sup>.

The desired transport mode is selected in large part depending on the travel conditions.

The experience of many countries that has accumulated in recent decades suggests that transport-related challenges, especially in medium and large cities, can only be solved through a systematic approach, one that entails:

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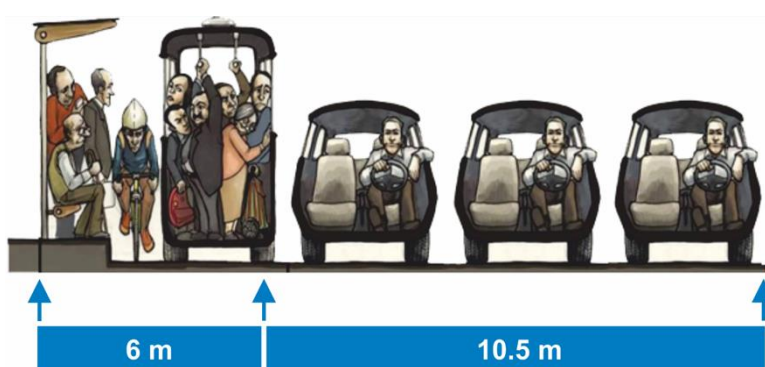
<sup>40</sup> According to the Green Mobility initiative, supported between 2013-2017 by the Nordic Council of Ministers (Copenhagen) which is being carried into effect by ICSEER Leontief Centre (based in St.-Petersburg), [www.mobility.leontief-centre.ru](http://www.mobility.leontief-centre.ru).

<sup>41</sup> Based on the answers given by Georgia to the UNECE questionnaire.

<sup>42</sup> Transportnoye planirovaniye: formirovaniye effektivnykh transportnykh sistem krupnykh gorodov (Transport planning: establishment of efficient transport systems in major cities) monograph / Y.V. Trofimenko, M.R. Yakimov. — M.: Logos, 2013, 26 p.

- knowledge of the characteristics and effects of different modes of transport on the urban environment;
- viewing transport as a functional system comprised of 66 different elements integrated for optimal use;
- concerted efforts to strike a balance between the behaviour of individuals and transport system efficiency as a whole and, to ultimately render the entire agglomeration efficient;
- the short-term and long-term roles of different modes of transport coupled with their impact on the natural and traditional urban environment must be factored in;
- all aspects of social justice must be taken into account: the transport system should provide a reasonable level of mobility for the entire population;
- use of modes of transport that can contribute to the creation of a humanitarian-oriented urban environment;
- a phased plan must be drafted to implement activities aimed at creating a liveable city<sup>43</sup>.

**Figure 2.24 Distribution of street space between traffic users**



Specific measures of sound transport policy can and should have an effect on the transport behaviour of citizens by shifting the “point of balance of individual preferences towards social optimum.”

Priority passage (or *high-level right of way*) is at the top of the list of these measures which is implemented through dedicated

lanes, priority traffic light cycle phases at signalled crossings, accessibility to areas in the city which are off limits for private vehicle traffic, etc.

Implementing priority passage includes a variety of engineering and organisational measures in place to ensure a predominant position of public transport in urban space thus helping to increase the speed, regularity and improve the comfort of public transport trips which makes public transport more attractive to all citizens, including motorists. The tools used to ensure a rational transport policy encompass fiscal and organisational measures that make daily car trips to the city centre more expensive and inconvenient. What also merits mention is "Internalization of externalities", bringing user costs on urban road trips into line with the full amount of actual buildings, including social and environmental ones.<sup>44</sup>

1. **Principle No. 1.** A pedestrian is more important than a car. A cyclist is more important than a car. A shuttle bus or tram is more important than a car. All motorists are equal. A car on the move is more important than a parked car as the former is engaged in a useful transport activity and the latter is not.
2. **Principle No. 2.** The only part of urban space where a motorist is not a depressed road user and where he or she sees no pedestrians, cyclists or public transport stations is a network of urban highways. There is no advanced metropolis in the world where the road network is functionally stratified in a clear way. The first basic contour is the streets. The pedestrian takes precedence on the streets whereas the car traffic speed is strictly limited and traffic lights are installed. The second contour is highways; motorists being their

<sup>43</sup> Vukan R. Vuchik, *Transportation for Livable Cities* / translated from English by A. Kalinin under scientific editorship of M. Blinkin.: The Territory of the Future, 2011.

<sup>44</sup> [http://www.litres.ru/pages/biblio\\_book/?art=2874155](http://www.litres.ru/pages/biblio_book/?art=2874155) Vukan R. Vuchik, *Transportation for Livable Cities* / translated from English by A. Kalinin under scientific editorship of M. Blinkin.: Territory of the future; Moscow; 2011, ISBN 978-5-91129-058-0.



exclusive users. Speeds are high; junctions are few and far between and well-equipped; no pedestrians and traffic lights.

- Principle No. 3.** Each section of urban space, that is streets, passages, sidewalks, yards, has its owner. Parking unauthorised by the owner of the space is deemed an offense. Paid parking is a tool used to limit excess transport demand where it is impossible to put a constraint on it in another way. The capacity of parking spaces must be in line with the density of the built-up area<sup>45</sup>.

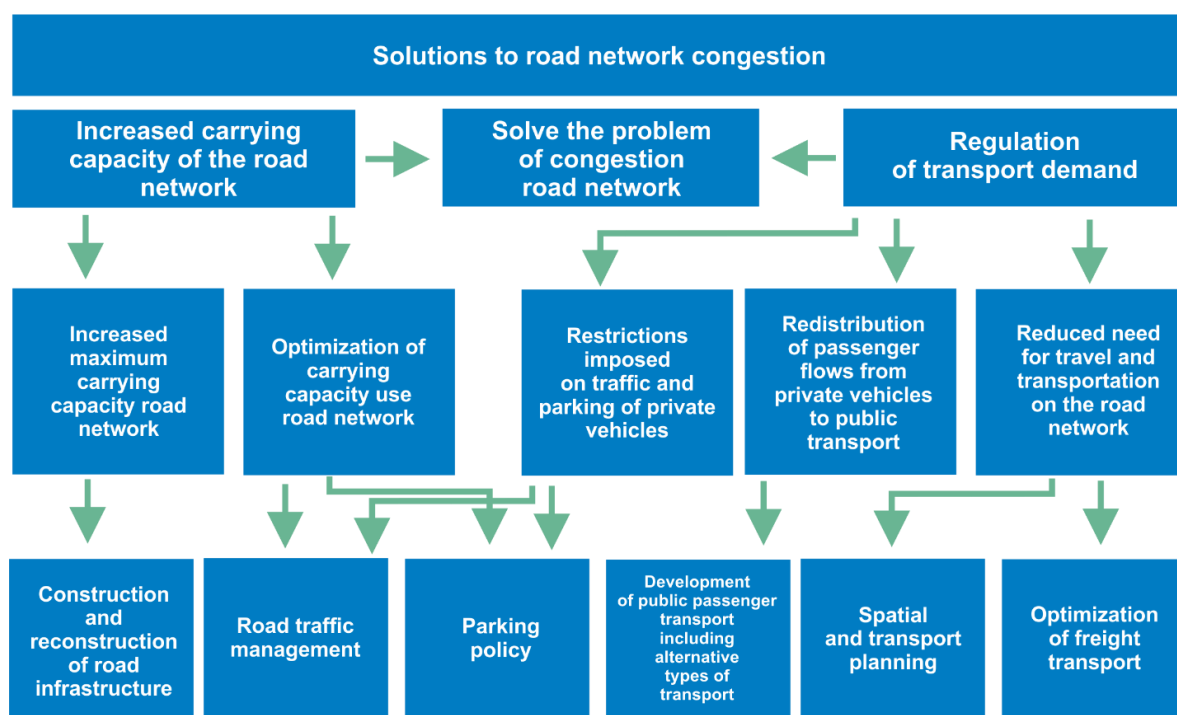
The principles listed above lead to the following common practices:

Moving around on foot is always convenient in a liveable city: multiple and extensive pedestrian areas can be comfortably reached by metro, tram, bicycle or taxi but cars are banned from them.

In city centres, cars are banned from parking on the motorway only allowed to stop to drop off passengers. Parking on sidewalks is limited by engineering means or administrative prohibitions. The idea is to impress on people that: It is difficult and expensive to park your car in the city centre; therefore, you need to use public transport or taxi to get there.

The city authorities, when sanctioning new construction works, shall ensure that this new (reconstructed) site will not hinder the traffic conditions in the vicinity. Also when the city authorities are in the process of approving a new traffic and parking space management policy, they must check whether these innovations are likely interfere with passenger correspondence as well as the cultural and historical identity and environment in the city.

**Figure 2.25 Solutions to road network congestion**

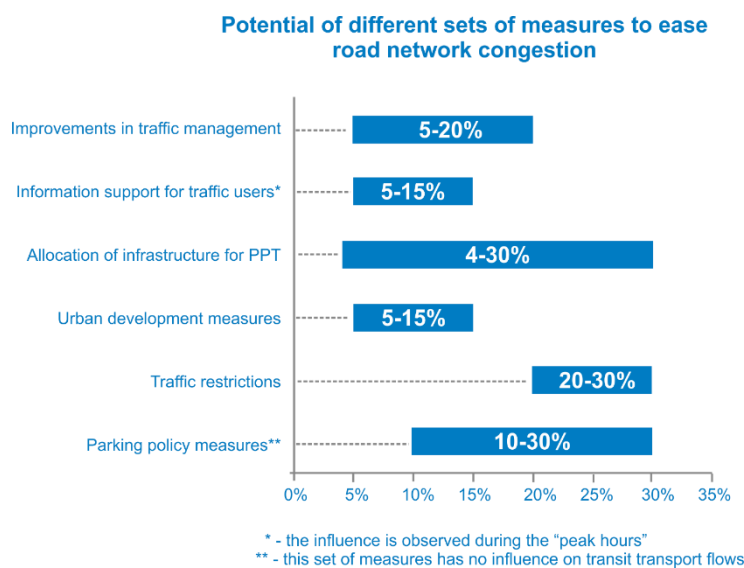


**Sustainable Urban Mobility Plans (SUMP)**

<sup>45</sup> [http://www.litres.ru/pages/biblio\\_book/?art=2874155](http://www.litres.ru/pages/biblio_book/?art=2874155) Vukan R. Vuchik, Transportation for Livable Cities / translated from English by A. Kalinin under scientific editorship of M. Blinkin.: Territory of the future; Moscow; 2011, ISBN 978-5-91129-058-0.



## 2.4.2 Urban freight traffic and city logistics



**Figure 2.26 Potential of different sets of measures to ease road network congestion**

Urban logistics should be seen as the practical organisation of the operation process of flows of materials, vehicles, people, energy, finances and information, as well as the management of (social, production, transport and logistics) infrastructure within the city agglomeration in the context of growing commodity exchange of economic entities.

In this regard, the integration of a city into a single tightly interconnected system of urban logistics facilities becomes possible by the following practical measures:

- the plans of various urban services must be harmonised in carrying out works which affect the capacity of highways and that capacity of parking lots;
- public transport locations (trade and office centres, companies and warehouses, educational and children's establishments) must be arranged in such a way as to take into account the logistic load of a particular area, flows of people and transport being different when a facility is open from when it is under construction;
- reducing the traffic of large vehicles around the city;
- the transport infrastructure must be planned taking into account the length of the various sections of the highways and their interconnection;
- divergent traffic flows must be arranged at different levels;
- expenses related to production and sale of finished products and services to the population must be optimised; the burden on the urban environment must be relieved;
- ensuring that municipal and city administrations provide unified management of procurement and supply for urban facilities, municipal facilities and institutions<sup>46</sup>.

When designing specific methods to organise these processes, two large-scale objects to be managed, freight and passenger transport, that form an integral part of urban logistics, must be taken into account. Both of them generate a flow of transport, ultimately functioning in a single system; each having characteristics of its own.

Despite freight transportation making up 10-15% of overall transportation activities, it handles all necessary deliveries within the city, such as: delivery of goods to retail outlets and retail chains; supply of short-lived commodities to restaurants, cafes, markets; home-delivery of goods; supply of building materials; garbage and waste collection (a kind of reverse logistics)<sup>47</sup>.

Given the large scale of distribution of goods flows, cities are faced with the challenge of managing them properly. Developing measures to optimise goods delivery needs to factor in not only uninterrupted traffic and timely delivery of goods to destinations, but also the environmental impact as well as the image of the city. Trucks have a major impact on global warming. While only accounting for 5% of the vehicles on the road in the European Union, they are responsible for 22% of road transport CO<sub>2</sub> emissions and this is only expected to

<sup>46</sup> Filimonov V. Gorodskaya/munitsipal'naya logistika (City/municipal logistics) <http://www.fill2001.narod.ru/GorodskayaLog.htm>.

<sup>47</sup> Rodrigue J.-P., Dablanc L. City Logistics, <http://people.hofstra.edu/geotrans/eng/ch6en/appl6en/ch6a2en.html>.

grow. Road freight transport is projected to increase by 56% between 2010 and 2050. At the same time 4,000 EU citizens die in truck accidents year after year.

The need to rethink and rationalise urban logistics is being pushed on the front scene by the boom of the number of transportations (exacerbated by the online shopping growth) as well as the growing sensitivity by the general public of the negative environmental and societal impact of fuel driven deliveries in saturated urban centres.

However urban logistics is a difficult issue to apprehend as it encompasses several levels of complexity: next to the heterogeneity of the goods transported and of the means of transportation, urban logistics encompasses a multiplicity of stakeholders (public transport authorities and other local authorities, transportation companies, shippers), each of which may have diverging interests and most of which will – in most cases – lack a shared understanding of the status quo, the priorities and the most appropriate action levers.

While local authorities will be interested by opportunities to reduce congestion, pollution and noise, transportation companies – even if willing to contribute to urban mobility objectives, thereby improving their image – will be mainly triggered by keeping costs under control while maintaining or increasing service level. This complexity may very often lead to partial, sub-optimal or even counter-productive decisions/solutions being enforced.

The establishment of a well-grounded urban logistic scheme strategy requires careful consideration of a number of dimensions. First of all, if a reform of urban logistics is to succeed, authorities need to set their priorities before selecting the most appropriate levers to achieve their objectives. After all, while they may be tempted to impose restrictions on trucks entering the city, they do not want to be blamed for harming the economy by raising the shippers' costs and reducing service levels. These measures need to be developed in a concerted way with the transportation companies, as well as the shippers/recipients around a shared series of objectives.

An urban logistic strategy can typically contribute to several goals, each of which can be influenced by different factors and some of which may be conflicting with each other, thereby requiring careful prioritization:

- Urban congestion reduction, influenced by distance travelled, vehicle capacity & length, and easiness to stop;
- Reduction of number of trucks in the city, influenced by vehicle capacity, vehicle filling ratio and congestion level;
- Pollution reduction (i.e. CO<sub>2</sub>/NO<sub>X</sub> and PM), influenced by vehicle type, distance travelled and congestion level;
- Noise reduction, influenced by vehicle type, distance travelled and congestion level;
- Development of local economy, influenced by solution costs, impact on service quality (speed, delivery time slots, flexibility/reactivity, etc.);
- Contribution to housing policy (increasing housing space within city limits), influenced by inner city logistics platform footprint.

Figure 2.27 Key statistics - trucks, buses and coaches in the EU region<sup>48</sup>

<b>EU total road transport emissions</b>	Heavy duty vehicles (trucks, buses and coaches) are responsible for 27% of road transport emissions
<b>EU total emissions</b>	Ca. 6% of EU total greenhouse gas emissions
<b>Increase of emissions since 1990</b>	HDV emissions have increased by 25% from 1990
<b>Projected increase</b>	Without action, emissions are projected to increase by 9% between 2010 - 2030
<b>Lorry fuel economy improvement since the 1990s</b>	Over the last 15 years, fuel economy of average trucks has not improved
<b>Potential to make trucks more fuel efficient</b>	Compared to 2015, diesel trucks can become 43% more fuel efficient by 2030 by applying a wide range of vehicle technologies
<b>EU policies to decarbonize trucks</b>	In May 2018, the European Commission made a proposal for the first ever European fuel efficiency standards for trucks
<b>Air pollution cost of trucks</b>	45 billion euros in increased health costs according to the European Environment Agency
<b>European oil imports for trucks</b>	500 million barrels of oil, at a cost of around €60 billion
<b>The real cost of trucks</b>	Only 30% of the societal costs of HGVs (pollution, noise, infrastructure) are covered by revenues from taxes and charges
<b>Natural gas trucks</b>	Trucks powered by LNG do not have appreciable climate benefits.
<b>Road freight can be decarbonised</b>	T&E study shows how to decarbonise heavy duty vehicles by 2050, necessary for the EU's Paris Agreement commitments
<b>Electric trucks are not science fiction</b>	Battery electric trucks are better for the environment and are technically and economically viable
<b>How much do trucks transport?</b>	75% of all goods carried over land in Europe, 1 831 billion tonne-km in 2016
<b>Importance of EU truck makers</b>	EU truck makers are responsible for ca. 40% of global truck production
<b>How much congestion do trucks cause?</b>	20% of road congestion costs in the EU are caused by trucks, despite representing just 3% of road vehicles
<b>Road safety impact of trucks</b>	With 3% of vehicles, trucks kill ca. 4200 people every year, around 15% of total EU fatalities

<sup>48</sup> <https://www.transportenvironment.org/what-we-do/cleaner-safer-trucks>, Transport & Environment, Brussels, Belgium, 2018.

### 2.4.3 Case studies and good practices

Figure 2.28 Levers to consider when defining appropriate urban logistic schemes<sup>49</sup>

Lever	Description
Urban Distribution Center (UDC) out of town	<ul style="list-style-type: none"> <li>Massified delivery to Urban Distribution Center upstream of city</li> <li>Delivery route preparation in UDC</li> <li>Often coupled with Exclusivity zone and/or greener trucks</li> </ul>
Direct injection	<ul style="list-style-type: none"> <li>Preparation of delivery routes in containers</li> <li>Transport of containers by massified transportation means (train, boat) and transfer to another mode for last mile transportation</li> </ul>
Urban Distribution Center (UDC) in town	<ul style="list-style-type: none"> <li>Massified delivery to urban distribution center within city core</li> <li>Delivery route preparation in Urban Distribution Center</li> <li>Often combined with Exclusivity zone and/or Greener trucks</li> </ul>
Exclusivity area	<ul style="list-style-type: none"> <li>Exclusivity (usually city core) to a single transportation company</li> <li>Can be limited to some truck sizes and/or time slots</li> </ul>
Traffic lane/drop off space reservation	<ul style="list-style-type: none"> <li>Booking of dedicated stopping spaces/traffic lanes</li> </ul>
Time slots	<ul style="list-style-type: none"> <li>Opening/shutting of specific times slots for some types of trucks</li> </ul>
Greener trucks	<ul style="list-style-type: none"> <li>Usage of "greener" trucks (Euro NCAP 5, gas, electric)</li> <li>Often combined with restrictions</li> </ul>
Alternative transportation means	<ul style="list-style-type: none"> <li>Delivery by alternative vehicles (bicycles, etc.) with a smaller capacity and range</li> <li>Usually combined with Direct injection or UDC in town</li> </ul>
Congestion charge	<ul style="list-style-type: none"> <li>Implementation of congestion charges</li> <li>Can foster development of UDC at congestion charge border</li> </ul>
Lever efficiency strongly depends on transport authority's ability to enforce rules	

In all cities throughout Europe, urban freight and last-mile logistics are a growing concern, linked with the exponential development of on-demand shipping.

#### Italy's Largest Low Emission Zone "Area B" is launched in Milan<sup>50</sup>

In an attempt to combat congestion and air pollution, Milan has limited city access further for petrol and diesel vehicles. With an area covering approximately 72% of the entire municipal territory, "Area B" is now Italy's largest low emission zone.

"Area B" is a region of 97.6% of the city's resident population (almost 1.4 million inhabitants). It impacts all those who enter the city by motor vehicle every day, steadily and progressively restricting the most polluting ones in a bid to enhance air quality.

Euro 0 petrol vehicles and Euro 0, 1, 2 and 3 diesel vehicles are now banned within this area from Monday to Friday between 7:30 and 19:30 (excluding holidays). On 1st October 2019, Euro 4 diesel vehicles will also be banned (these have been banned from the central "Area C" since 2017). Gradual bans for other classes of passenger and freight vehicles will follow until 2030, the point which all diesel vehicles will be banned in Milan.

The introduction of "Area B" has been described by the municipality as "part of a definite, progressive and gradual set of rules to reduce particulate matter and improve urban quality in Milan". They predict air pollution to decrease dramatically in the next few years: it is expected that atmospheric traffic emissions will reduce by roughly 25 tonnes of PM10 and between 900-1,500 tonnes of NOx by 2026.

<sup>49</sup>[https://www.uitp.org/sites/default/files/members/140124%20Arthur%20D.%20Little%20%20UITP\\_Future%20of%20Urban%20Mobility%20%200\\_Full%20study.pdf](https://www.uitp.org/sites/default/files/members/140124%20Arthur%20D.%20Little%20%20UITP_Future%20of%20Urban%20Mobility%20%200_Full%20study.pdf), Arthur D. Little and International Association of Public Transport (UITP), The Future of Urban Mobility 2.0, 2014.

<sup>50</sup> <http://www.eltis.org/discover/news/italys-largest-low-emission-zone-area-b-launched-milan>, Hannah Figg, April 2019, United Kingdom.

This news comes just weeks before the Ultra Low Emission Zone (ULEZ) comes into force in London, where drivers of older, more polluting vehicles (up to Euro 4 for petrol and Euro 6 for diesel) are now being charged to enter the congestion zone area at any time.

Since 2011, the Government of Moscow has been systematically implementing a set of measures to regulate the traffic of freight vehicle throughout the city of Moscow in the daytime. Certain areas are open for passage and traffic only for trucks included in the Register of Valid Passes.

These measures have led to the number of transit trucks in Moscow diminishing by 25% with the average daily traffic speed on the Moscow Automobile Ring Road climbing by 4%. The road network of some administrative districts of Moscow, those that are especially susceptible to high traffic intensity of freight vehicles, for instance, the Northern, North-Eastern and Eastern administrative districts of Moscow, have gone ahead with the “cargo frame” project under which the traffic of trucks with a maximum weight of more than 2.5 tons has been restricted on a round-the-clock basis (on the “cargo frame” streets). This has helped improve a number of environmental aspects, achieve reduced noise levels in residential areas and overall improvement of the road transport situation.<sup>51</sup>

In Minsk (Republic of Belarus), the government has introduced restrictive measures on the passage of trucks with a total weight of more than 1.5 tonnes on a number of central highways and roads that lead to them. In order to meet the needs of industrial and commercial facilities that are within the area where the restrictions are enforced, truck deliveries are handled by logistics technologies where goods are supplied by light trucks through logistics centres<sup>52</sup>.



**Figure 2.29 “La Chapelle International” integrated logistic hub in Paris, connecting railway, road and urban street network, was opened in June 2018 (source: Sogaris)**

## 2.5 Organisation of urban parking space and parking policy

### 2.5.1 Basic principles

One of the cornerstones of the state policy in traffic management is “organisation of the urban parking space and parking policy”.

The basic policy instruments used to create a single parking system in cities include:

- financial (economic measures, such as tariffs and fines);
- administrative (e.g. no-parking zones or parking

time limits);

<sup>51</sup> The map of the cargo frame of Moscow can be found on the Unified Transport Portal at: <http://transport.mos.ru/>. In addition, commercial freight vehicles below environmental class 3 are barred from entering the central part of the city which is limited to the Third Transport Ring (TTK), as well as being prohibited from driving along the Third Transport Ring. These restrictions are in force 24 hours a day.

Restrictions on the traffic of freight vehicles are enforced both in automatic mode (by traffic cameras) and by employees of the State Road Traffic Safety Inspectorate, the Department of the Ministry of Internal Affairs of Russia in Moscow. Vehicles are identified by their state licence plate numbers.

These restrictions apply to all freight vehicles, regardless of their place of registration, ownership and purpose. Whenever found to have violated the Road Traffic Regulations on several occasions, a driver will have their issued permit revoked<sup>51</sup>.

<sup>52</sup> Based on the answers given by the Republic of Belarus to the UNECE questionnaire.



- urban planning (enforcing regulation of standards for the design of parking lots and their capacity in new residential developments);
- others (this group includes physical barriers, methods to use parking space in alternative ways, tools for development and promotion of public transport, bicycles and motorcycles, etc.).

In creating a single parking space in a city, a set of interrelated regulatory and non-regulatory acts need to be adopted which would establish:

- responsible authorities to make decisions on the establishment of a single parking space and the environment required for it to function;
- the procedure for making decisions on creation of a single parking space which would also determine the scheme to create parking space facilities;
- empowering the organisation that is building and operating parking spaces that make up the single parking space;
- rules for the use of parking spaces that make up the single parking space;
- rules for setting fees for the use of parking spaces within the single parking space;
- introduction of administrative accountability for violation of the rules that govern the use of parking spaces facilities, including failure to pay fees.

The legal nature of parking fees can be defined as follows: non-tax revenues derived through service delivery or non-tax revenues from the use of property. The legal schemes behind the establishment of parking space facilities, which make up the single parking space may include: transfer of relevant functions and powers to a budgetary institution, which subsequently places a municipal order to create and operate the facilities, or attract a private partner on a competitive basis under PPP projects.

The organisational modalities behind the establishment of a single parking space is directly dependent on what scheme is chosen by the local governments to create parking space.

In this case, the optimal combination of the operational mode of parking space facilities and benefits for residents in certain areas is fundamental to an effective parking policy.

From the perspective of pricing objectives, the following approaches to establishing parking fees can be distinguished:

- a) improved traffic conditions;
- b) guaranteed free parking spaces.

Guaranteed parking spaces are the most appropriate approach to establishing parking fees inasmuch as it ensures balanced supply and demand with the fee set in strict compliance with the scope of demand and availability of parking spaces.

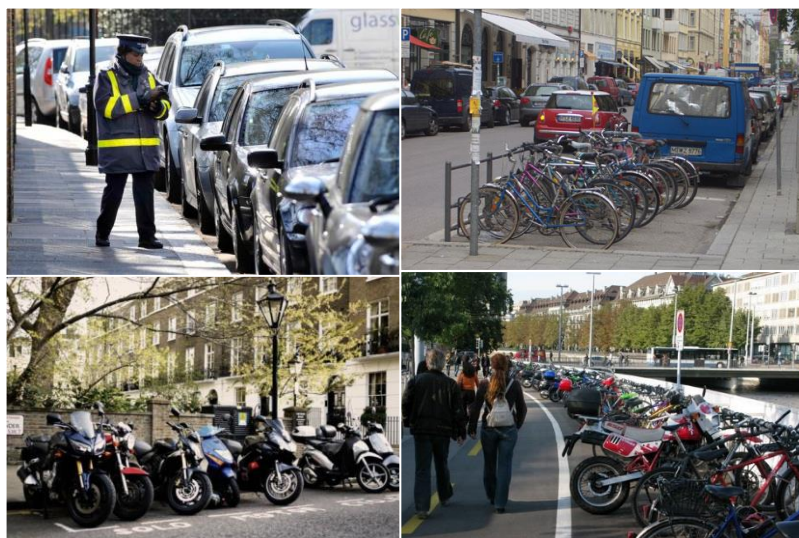
The experience of European countries when examined demonstrates that the introduction of single parking space systems, including paid parking lots in the street and near the road, promoting the creation of off-street parking space and park-and-rides has resolved the problem of congestion in cities, especially in their central areas, reduced traffic flows by about 30 percent and improved transport accessibility to major places of attraction.

## **2.5.2 Case studies and good practices**

The following peculiarities unique to the development of parking policies in some advanced European cities should be underscored:

In London, when a vehicle is registered to enter to city's toll system, the emissions of harmful substances declared by the manufacturer are registered in a special database. This approach allowed administrative districts to charge parking fees based on the level of emissions of vehicles. In Munich, Germany, enforcing a policy of widespread restrictions on urban parking to encourage citizens to completely abandon private vehicles in favour of public transport has

proven to be a success. This policy has gone with a comprehensive approach to public space transformation, a trend that many European cities are following.



**Figure 2.30** Parking inspector on duty in Westminster County, London, parking areas reserves for two wheel vehicles in Grosvenor square, London, car parking space in one of the central streets of Munich combined with a bicycle parking lot, dedicated parking area for two wheel vehicles in Zürich (Switzerland).

The competition for innovation between European cities is intensive. Barcelona prides itself to be the first city to use 100% of

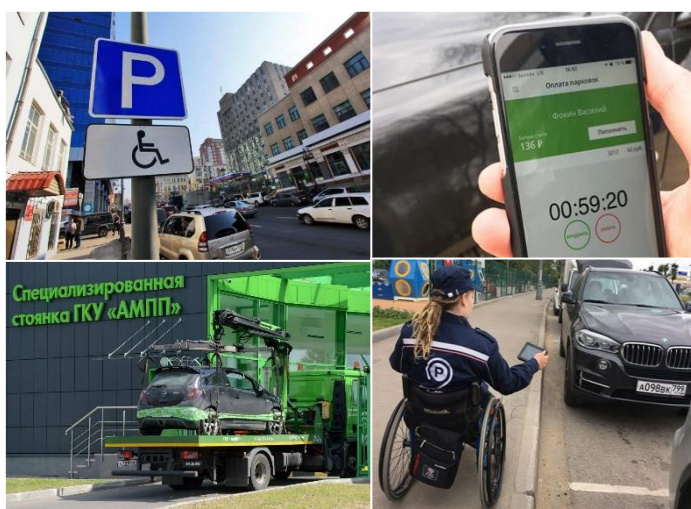
the proceeds from parking to fund a public bike rental program. Paris (France), has one of the densest network of bike sharing system in the world and the municipal government has launched several initiatives to expand public spaces at the expense of cars. In Copenhagen too, thousands of metres of street space have been transformed into a pedestrian zone while hundreds of parking spaces have been removed.

the peculiarities of specific cities, all the measures under examination are aimed at reducing the total distance travelled by private cars within the city, as well as at developing and promoting public transport. In that context, new issues are arising, such as the management of the enforcement of new regulation systems. In many cities, law enforcement is now being outsourced to private companies who developed sophisticated digital monitoring systems to control parking. This trend goes with other technological innovations of parking metering (electronic database of private vehicles, scanning cars).

**Figure 2.31 “Moscow Parking Space” Project**

Since the 1990’s, the situation of street parking in Moscow was notoriously chaotic. Launched in 2012, the municipal government has launched the project “Moscow Parking Space” designed to enable comfortable traffic of pedestrians, public transport vehicles and motor vehicles.

Since it was launched, the total amount of proceeds collected by paid parking in the city of Moscow and transferred for urban improvement purposes has amounted to more than 19 billion rubbles (260 million €). The most popular mode of payment among drivers is the “Parking of Moscow” mobile application (it is used by 84 percent of drivers). The outcomes are very positive, with an increase in the traffic speed by 12%, a decrease in the number of parking violations by 64%, a decrease in the



number of private vehicles entering the Garden Ring Road by 25%, an increase in the turnover of car space by a factor 4.<sup>53</sup>

**Figure 2.32 Tbilisi (Georgia) new transport and parking comprehensive policy**

Tbilisi City Hall Transport Policy is focused on the public transport and non-motorized mobility. Making Public Transport comfortable, fast, reliable and safe is the main approach of the policy which will result in enhanced use of PT.



Tbilisi City Hall has finished working on the new parking system, which involves zonal parking and increased parking fees. From spring 2018, it will be gradually implemented in the city infrastructure. It will significantly contribute to the reduction of the number of private cars in urban areas and encourage public transport and cycling.

The new zone parking system is aimed at the efficient regulation of parking and the normalization of traffic in the city; Bus Lanes, New road traffic organization schemes and etc. The City Hall has also introduced bus lane arrangement on Pekini and Shartava streets. It is also planned to implement bus lanes on every major street<sup>54</sup>.



**Figure 2.33 Park-and-ride on Radialnaya Street in Minsk (Republic of Belarus) and in Saint-Petersburg (Russian Federation)**



In the Republic of Belarus, measures taken to regulate transport demand include the development of a park-and-ride network where a car is left in a parking lot with the owner transferring to public transport. In Minsk, there are currently two such parking lots with a capacity to accommodate 100 vehicles and 60 vehicles respectively. There are four ways to pay the parking fee: via the parking card, by sending a text message or ussd i.e. a request to a common short number, through a parking metre or a payment terminal, as well as via mobile or Internet banking (United Payment and Information Space)<sup>55</sup>.

In St. Petersburg (Russia), the State University “City Centre for Parking Management in Saint-Petersburg” is developing a network of park and rides in order to reduce traffic in the centre of St. Petersburg. Putting them to use will help citizens reduce travel time and avoid traffic jams<sup>56</sup>.

### 2.5.3 The key towards successful parking space management strategies

#### Pricing

##### Street parking tariffs

<sup>53</sup> <http://parking.mos.ru/>, as well as based on the answers given by Moscow (Russia) to the UNECE questionnaire.

<sup>54</sup> Based on the answers given by Tbilisi (Georgia) to the UNECE questionnaire.

<sup>55</sup> Based on the answers given by the Republic of Belarus to the UNECE questionnaire.

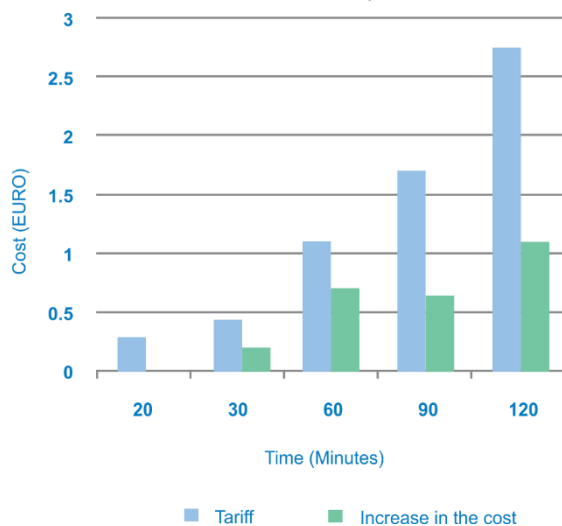
<sup>56</sup> <https://www.gov.spb.ru>, the official website of the Administration of St. Petersburg.



A fee for using street space is usually introduced in order to optimise the use of the roadway (motorway). It influences the extent to which space is used minimising the number of cars which slow down traffic in search of parking space. The fee is set based on the demand sensitivity (that is, depending on the target levels of parking space filling and availability of free spaces). Most often, drivers prefer to park as close as possible to their destinations, even if they block the traffic lane or pedestrian paths<sup>57</sup>.

Market pricing mechanisms can change the behaviour of people who choose to use motor vehicles. An important factor in the optimal regulation and management of parking space is the harmonisation of fees charged for street and off-street parking. The fees should be aimed at encouraging drivers to opt for off-street parking.

A number of European cities have established “Controlled Parking Areas” that is designated areas within a city ranging from one block to a whole district. In London, for example, the Controlled Parking Areas enable the administration of each city district to set tariffs and rules of parking according to local conditions. An example is a special parking fee in a popular shopping area: the fee for long parking hours goes up in order to deter motorists who use the parking space during the working day. Thus, the preference is given to visitors who come around for a short time to do the shopping or owners of local businesses. A similar approach is pursued in Zurich and Munich, where prices vary from block to block, the popularity of a location and the time of day.



### Progressive pricing methods

**Figure 2.34 The progressive scale for parking space fee in the Blue Zone, Madrid, Spain**

Zurich, Antwerp, Vienna and Madrid have street parking pricing schemes that increase the fees charged over time. This measure is aimed at setting an increasing marginal cost for the presence of a car in a parking lot — the longer a car is parked, the more expensive each subsequent hour is. Visitors who come to Madrid can park their cars in a parking lot for a maximum of two hours with the fee for each subsequent interval of time going up by a certain proportion.

### Parking regulations at the place of residence

Trips between the city's central business district (CBD) and residential areas have prompted the municipal authorities of most European cities to introduce special parking permits in residential areas. Thus, managing the demand for parking among residents in a particular area has become more effective as the needs of local residents for parking near their places of residence are significantly different from the needs for visitors in transit.

<sup>57</sup> Simon Anderson and André de Palma (2004). “The economics of pricing parking,” *Journal of Urban Economics*. University of Virginia. Volume 55, Issue 1.

**Figure 2.35 Example of biking stations in Lyon (France), Barcelona (Spain)**

### **Taxation for companies that reserve street parking spaces**

There is a practice of imposing additional taxes on companies and enterprises that provide parking space for their employees.

### **Defining the assignment and reservation of funds to achieve social goals (target expenditure of budgetary funds)**

Barcelona, Strasbourg, Munich and some administrative districts of London follow the practice of allocating profits from parking funds to support environmentally friendly transport. Such a policy can receive public support provided that the surplus funds are used to improve public transport, pedestrian and cycling infrastructure.



## **Regulations**

### **Limiting the number of parking spaces for cars**

Hamburg, Zurich<sup>58</sup> and Budapest have introduced a maximum limit on the availability of parking spaces in the central areas by consolidating the reform of the new building standards. This reform limits the existing number of parking spaces with a further ban on the expansion and construction of new parking areas. Thus, each off-street parking space within a limited area should result in the same number of street parking spaces eliminated

### **Introduction of a parking maximum limit**

The idea of introducing a parking minimum limit is to shift the responsibility of providing parking space in new residential areas to private developers. However, it is difficult to predict the amount of parking demand in new residential areas at the moment, as there are still no accurate calculation algorithms. Thus, most experts on parking regulation cannot provide a logical justification for parking requirements for new buildings. Thus, the costs of lost opportunities end up with developers, who prefer to use the free area for other purposes.

For example, the authorities in Zurich tried to regulate the demand for parking while implementing the SilCity project. In this case, they made it obligatory for the developers to carry out the project, taking into account the preferences of local citizens in public transport, bicycles and walking.

Parking requirements in European countries will be more severely restricted in the future depending on the availability of public transport. This trend has already affected the urban life of Antwerp, Paris, Amsterdam and Zurich. The policy applied in the Netherlands under the name "A, B, C" has significantly changed urban parking standards, using the distance of certain parking spaces to public transport stations as the basis for parking space separation. The supply of parking space should be as limited as possible in the construction of residential areas closest to major public transport hubs (location A). In those new areas that are far from large hubs (location B), much more parking spaces are created.

For instance, in Paris it is forbidden to build a parking lot in a new building, located at a distance of not more than 500 metres from a public transport station. It should be noted that almost all buildings located in the central part of the city meet this requirement - metro stations are located quite close to each other.

### **Regulating the location of parking space**

<sup>58</sup> Zurich Historic Compromise Parking Cap. Accessed online October 2010. URL: [www.stadt-zuerich.ch/parkplatzkompromiss](http://www.stadt-zuerich.ch/parkplatzkompromiss)



Cars passing through in pedestrian areas may be restricted or prohibited altogether. Exceptions are usually emergency and courier vehicles that operate at certain times of the day. Such bans and restrictions have already been introduced in most historical centres of European cities. Some categories of vehicles are not allowed to enter the city centre because of their pollution levels exceeding the established standards. This strategy is used in the following cities: Berlin, London, Milan and others. In addition, cars with high exhaust emissions are also prohibited from parking within the city.

### **Coping with a new generation of challenges**



**Figure 2.36 Unregulated free floating mobility devices threaten the environment and raise concerns regarding safety and cohabitation with pedestrians in dense urban centers**

While cars are the main target of new parking regulations, it should be noted that public space is affected by a new generation of mobility devices, especially free floating bikes or electric scooters, resulting in overcrowded pavements at the expense of pedestrians.

### **Design**

#### **Physical barriers against cars**

Paris and Milan have introduced bollards in all key locations. This prevents the accumulation of cars on walkways and in public places. In certain cases, alternative elements such as retractable bollards, vehicle barriers, bars to limit access to vehicles by their height and other elements are used to prevent access to conventional vehicles and provision of access and parking for emergency vehicles or other specialised vehicles.

#### **Marking lines**

In many European cities, such as Stockholm, white lines indicate areas of permitted parking. This is a kind of visual signal to let motorists know that the parking area is separated from other functional areas, to wit: pedestrian walkways, cycling paths, as well as the motorway.

#### **Promotion of public space alternatives**

The positive effects of the decrease in the number of parking lots are:

- improved visibility at intersections;
- reduced duration of the “pedestrian crossing” mode of traffic lights due to the pavement zone being consolidated at intersections;
- Greening works on roadsides;
- Increased territory taken up by cafes and restaurants in narrow streets, as well as new benches installed for rest of urban dwellers.

Reducing the number of free parking spaces in the streets serves as a way to encourage the use of alternative vehicles and improve the environment<sup>59</sup>. The development of the tram network in the city of Strasbourg (France) made it possible to move the street parking lots underground, as well as promoting the construction of park and rides near the key tram stations and expanding paid parking areas.

#### **A new geometry for roadways**

In those streets where parking is still permitted, there is a practice of reorganising the space in a way that meets the approved security requirements. In Zurich (Switzerland), parking space

<sup>59</sup> GTZ (2010). “Parking Management: A Contribution Towards Livable Cities,” Sustainable Transport: A Sourcebook for Policymakers in Developing Cities. Module 2C Division of Water, Energy and Transport.

organised in chessboard order on both sides of narrow streets serves as a zigzag obstacle to the traffic of cars, which reduces the average speed of traffic.

In Amsterdam (The Netherlands) there are so-called “residential street” zones (“woonefs”), where cars left parked by residents make up winding roads, forcing cars to move slower near cyclists and pedestrians. In Paris and Copenhagen (Denmark), cycling paths were put in place that are protected by parked vehicles, which in turn serve as a barrier between cyclists and vehicles on the move. In Copenhagen and Antwerp (Belgium), there are streets with children's playgrounds organised in the immediate vicinity of the roadway. However, these venues are separated by barriers, such as trees, benches and other structures, alerting motorists to the need to drive with maximum caution and with minimal speed.

### **Contractual relationship & technology**

The following are four types of technologies used for more efficient parking management.

#### **Free parking space electronic tracking system**

Calculations indicate that the average motorist in a European city spends on average about 25% of the total time of his or her journey by car in search of free parking space. Real-time timetables placed in convenient locations along the road are designed to facilitate the search for parking space and to guide motorists to the available parking spaces in the nearest parking lot. Almost all major cities in Germany rely on these parking management information systems. The next step in the development of these technologies will be the integration of embedded information systems in the car.

#### **“Smart” metres**

Smart parking metres are equipped with magnetic field sources which help to register the metal body of cars in their area of operation. These are directly connected to the police information system sending signals to the nearest parking inspectors in the event of a car winding up in the area of the counter. In turn, the driver of this vehicle receives a notification on his or her cell phone stating that he or she has entered a paid parking area. These metres are installed, for example, in all major cities in France, where they ensure that parking fees are collected in an efficient way.

#### **Payment for parking services via mobile devices or mobile applications**

At present, there are various methods to pay for parking space use, including prepaid cards, bank cards, coins. The payment system via telephone or mobile device is convenient for municipalities, as the responsibility for collecting money rests with a third-party company. In this case, there is no chance for paid funds to be lost.

#### **Parkon cars equipped with a scanning device**



**Figure 2.37 Example of automated fining system in Paris (France)**

Some administrative districts of London are currently using hidden cameras to enforce proper parking rules on the part of motorists.

The development of parking space management policy in the instances mentioned above is targeted at ensuring effective use of urban land, enhancement of the environmental situation, creation of a favourable, safe and comfortable living conditions of the population, stepping up the capacity of main transport routes, providing car owners with accessible and convenient places for parking.

To achieve effective management of parking space, the main four mechanisms are used: economic impact mechanisms, regulatory influence mechanisms, organisation of design works and contractual relationships.

A new wave of technological innovations in the field of control and collection of parking fees is the integration of electronic metres into new vehicles, which are connected with the navigation system and able to provide information on availability parking spaces and to guide motorists to their location. Navigation systems are also used to inform motorists on parking rates depending on the location, time of day and day of week.





## **Chapter 3.**

# **Public Transport Planning, the Cornerstone of Sustainable Urban Mobility**



## Chapter 3: Public Transport Planning, the cornerstone of Sustainable Urban Mobility

### 3.1. Public transport as a key element of a “liveable city”. Integrated urban development policies across the UNECE region

The main goal of modern cities, the meaning of life and doing business in cities is the range of opportunities that extend to the choice in employment, goods and services, maximum labour and sales markets. The way in which each of us is satisfied with our lives is determined, amongst other things, by being able to have choose the best workplace, where we can manage to realise the potential of our abilities and receive decent financial rewards; the best goods and services (including in culture, health care, etc.) that meet our personal needs. Business efficiency is also largely dependent on the best employees being picked who, although moderately remunerated, will be satisfied with their job. This also applies to suppliers and customers. Being the main mechanism behind economic development, transactions and purchases are the outcome of meetings of people, so the possibility to have such meetings is dependent on mutual transport accessibility for people and organisations.

Transport is a key mechanism for accessibility. Due to the human daily biological cycle, the time of daily trips (the time that a person is willing to spend on the move in order to access places of his or her interest) normally does not exceed 3-4 hours per day, which is corroborated by numerous surveys and studies. With travel time limited, the number of places and people accessible can be enlarged only by two ways: by driving up occupation density (a trend that can be seen in cities, Figure 3.1) and by stepping up the travel speed of the transport system (in order to cover as much of the area adjacent to one's place of residence and the places of interest located therein within the time available for travel, Figure 3.2).

**Figure 3.1. Madrid, Spain. This district perfectly illustrates both approaches to rise the accessibility in a city: the occupation dencity is risen with 5-6-story apartments, while the increased travel speed is provided with light rail line on a separated track.**



**Figure 3.2. Krasnodar, Russia. This light rail line deployed in the center of the avenue in order to reduce crossings and rise the speed of tram trains. The line is surrounded by the trees for**



**ecological and aesthetic reasons. The bushes provide the green fence for the safety and high-speed motion.**



The massive transition of consumers from public transport to private vehicles led to the issue related to the growth of total costs (extending to direct costs and externalities) for transport system operation aggravating. The main issue was that territories required space for the passage and parking of cars: congestion-free mass transportation of the same number of people by car will take 4 times more space of the road network as compared to bus transport and 12 times more in comparison with the tram. For a car to be parked, more common area in the building is required than for one office employee (i.e. each office building would have to have a parking building of similar dimensions next to it).

Accessibility (the number of places in demand covered) as a target function of the transport system is determined by the density in which objects are in relation to each other and the speed of transportation. The transportation speed considerably decreased due to densely located historical buildings (“tram suburbs”), that were not designed for mass car traffic: the lack of land for the road network to expand led to constant traffic congestion while the construction of multilevel junctions and parking spaces required the urban buildings to be demolished which was unacceptable.

**Figure 3.3. Lack of transport governance and car demand management, weak public transit planning lead to the poor conditions for all the participants of transport system, reduces quality of life and city economy.**



An attempt to ensure high speed of transportation in new built-up areas through balanced transport management (balance of the road area, flat parking spaces and building density where the demand generated by the building density was to be fully met by motor vehicles without traffic congestions and parking space deficit) led to a substantial decrease in the building density as well as to the phenomenon known as “urban sprawl” that stands for low density urban areas sprawling. In both cases, the substitution of public transport with private vehicles, as ironically as it may sound, led to reduced accessibility, due to either a drop in congestion-related transportation speed or in the density of buildings in terms of accommodating the road network and parking lots.

Mass car use has led to externalities growing along with the excessive demand for territories and reduced accessibility of transport, air pollution resulted in a spike in morbidity and mortality; noise pollution; shrinking appeal of the historical urban environment (it became “inconvenient” due to the lack of a sufficient number of parking spaces in historical areas, so the expanding roadways at the expense of sidewalks and sprawling parking lots at the expense of lawns detracted from the attractiveness of pedestrian traffic) as well as increased demand for shopping malls in the suburbs adapted for car access; a higher number of traffic accidents; growing direct budget costs for transport services management (construction and maintenance of the street and road network).

The purpose of public transport was transformed from “transport for the poor” at the end of the 19th century to “transport for sustainable development” at the turn of the 21<sup>st</sup> century. As of today, mobility and transportation plans are still largely being developed in parallel or with too narrow connectivity with urban plans (masterplans). Yet, the convergence of land use and mobility is a key for territorial sustainability.

## 3.2 Why public transport should be the backbone of spatial plans

### 3.2.1 Comparative assets of mass transit and individual mobility

As individual mobility is not declining, and urban sprawl is a reality, it makes sense to review a series of comparative assets of mass transit and individual mobility, be it about environment, budgets, safety and quality of service.

**Environmental impact.** Studies show that emissions of pollutants can be reduced by 1.3-5 times owing to transportation by bus as compared to private vehicle transportation, and by 4-1,000 times by using rail transport (including energy production, Figures 3.4 and 3.5)<sup>60</sup>.

Electric public transport pollutes the atmosphere tens of times less than private motor vehicles even taking into account electricity generated by power plants. In Manchester, for example, 62% of the electricity that feeds the tram system is generated by wind farms causing zero environmental damage<sup>61</sup>.

In addition to fuel pollution, urban air pollution with micro particles caused mainly by the friction of tyre treads against the road surface, is of great importance. Studies show the total amount of motor vehicles' braking system wear estimated as 8.8 to 20.0 mg/car -km, for buses it is in the range of 47 to 110 mg/car-km.<sup>62</sup> As city buses transports 10-20 times more passengers than cars per kilometre (per day), the bus-related particle emission per passenger-kilometre is 4-5 times lower. The most promising mode of transport in this respect is rail transport with the wheel tread wear significantly less than that of road transport. This being said, the chemical composition of rail dust is less dangerous to the body. In general, the greater the capacity of the vehicle, the less pollution is generated per passenger transported in standard passenger load on the vehicle.

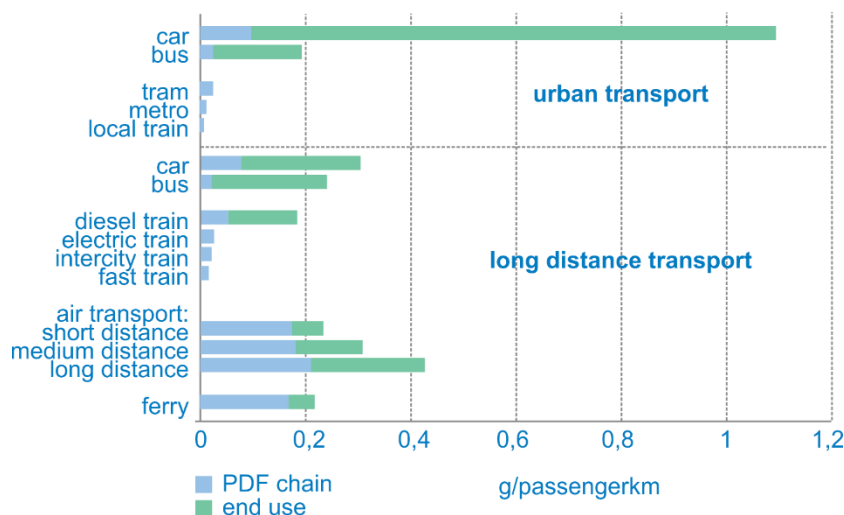


Figure 3.4 Emissions by mode of transport, including fuel production and delivery, as well as in traffic, g/pass-km.

Figure 3.5 Emissions by mode of transport, including fuel production and delivery, as well as in traffic, g/pass-km.

<sup>60</sup> [http://www.trafikdage.dk/td/papers/papers96/tr\\_og\\_em/kaleno/kaleno.pdf](http://www.trafikdage.dk/td/papers/papers96/tr_og_em/kaleno/kaleno.pdf)

<sup>61</sup> <https://www.tfgm.com/environment/public-transport>.

<sup>62</sup> Garg B. D., Cadle S. H., Mulawa P. A. [et al.] // Environmental Science and Technology. — 2000. — Vol. 34. — P. 4463–4469.; Sanders P. G., Xu N., Dalka T. M., Maricq M. M. // Environmental Science and Technology. — 2003. — Vol. 37. — P. 4060–4069



	CO	HC	NO.	SO.	part.	Co <sub>2</sub>	N <sub>2</sub> O
<b>urban areas</b>							
<b>road transport</b>							
car (**)	8.339	1,098	0.799	0.091	0.077	194	0.0497
bus	0.333	0,199	1.170	0.031	0.059	67	0.0262
<b>rail transport</b>							
tram	0.010	0,019	0.029	0.028	0.027	9.2	0.0011
metro	0.004	0.008	0.012	0.012	0.011	3.9	0.0005
local train	0,003	0,006	0.008	0.008	0.008	2.7	0.0003
<b>long distance transport</b>							
<b>road transport</b>							
car (**)	2.659	0,308	1.034	0.066	0.079	119	0.0391
bus	0,360	0,245	1.460	0.029	0,163	62	0.0301
<b>rail transport</b>							
diesel tram	0,195	0,179	0.953	0,103	0,023	67,5	0.0003*
electric train	0,014	0,026	0.040	0,038	0,037	12,5	0.0015
Intercity train	0,011	0,019	0.030	0,028	0,027	9,3	0.0011
fast speed train	0,007	0,013	0.020	0,019	0,018	6,1	0.0007
<b>air transport</b>							
short distance (200 km)	0,574	0,234	0.741	0,204	0,007*	217	0.0012*
medium distance (300 km)	0,605	0,309	1.055	0,210	0,008*	230	0.0012*
long distance (> 500 km)	0,717	0,429	1.799	0,245	0,009*	268	0.0014*
<b>ferry transport</b>							
	0,344	0,218	4.536	1.610	0,137	220	0.0011*

\* includes only the emissions during the production and distribution of the fuel  
 (\*\* passenger car fleet at year 1994)

**Distribution of space.** The distribution of street space between modes of transport is determined by the carrying capacity, i.e. the number of passengers that a system can handle per one available lane. The carrying capacity of a 3.5 m wide strip for buses and bicycles is approximately the same — about 4.000 consumers per hour, which is about 4 times higher than the carrying capacity of motor vehicles (about 1.000 — 1.200 passengers per hour).

Rail transport has the highest carrying capacity of all: with intersections in one level, it is able to handle up to 12.000 consumers per hour, without intersections — up to 50.000 per hour. Accordingly, when there is a lack of capacity, space is first allocated for rail transport, then for pedestrians, non-rail public transport and cycling transport with the rest distributed for private motor vehicles; with a lack of capacity (for motor vehicles), the fee for travel through the road section is upped but an alternative represented by transport with maximum carrying capacity is offered (rail transport, in its absence - road public transport, and also cycling as an addition to public transport, see examples at Figures 3.6-3.8).

**Figure 3.6. Geneva, Switzerland. The road space is divided between all the modes – rail transit, pedestrians, bikes and cars. Only single line is provided for cars.**





**Figure 3.7. Moscow, Russia. The narrow street space is divided reasonably between pedestrians, cyclists and bus/car traffic.**



**Figure 3.8. Dusseldorf, Germany. Separated cycling lane passes bulb tramway stop.**



**Direct costs related to transport service management.** The data obtained by the Centre for Project Infrastructure Economics in the Russian Federation point to the fact that as the capacity



of transport vehicles increases, the net cost of passenger transportation decreases (Figure 3.15).

**Road safety.** Road accident statistics in the Russian Federation in regard to accidents caused through the fault of motorists and the number of passengers carried per mode of transport, out of 1 million passengers transported: 6,07 accidents are caused by private vehicle drivers, 0,45 accidents are caused by bus drivers, 0,27 accidents by trolleybus drivers, and only 0,11 accidents are caused by tram drivers (Fig. 3.9). Therefore, a mayor who ensures that passengers are transported by bus instead of by car will reduce the number of road accidents by 13.5 times whereas when transported by tram, the numbers will go down by 55 times in comparison to car transportation.

**Figure 3.9. Number of road accidents caused by motorists per one passenger transported in the Russian Federation**

№	Type of transport	Transportation of passengers, mln. per year	Absolute figures of traffic accidents (due to the driver's negligence)			Number of road accidents per 1 mln. of passengers carried		
			Road accidents	Dead	Injured	Road accidents	Dead	Injured
1	2	3	4	5	6	7	8	9
1	Passenger car	19,027	115,428	13,100	157,846	6,07	0,688	8,30
2	Bus	11,722	5,294	257	8,194	0.45	0.022	0.70
3	Trolleybus	1,483	402	10	434	0.27	0.007	0.29
4	Tram	1,397	149	7	201	0.11	0.005	0.14

A similar pattern is observed for deaths and injuries. Transportation by bus will reduce mortality by 30 times and injuries - by 12 times in comparison with transportation by car. Transportation by tram will reduce mortality by 137 times as compared to transportation by car (4.4 times compared to the bus), the number of injuries - by 60 times (5 times compared to transportation by bus).

In general, a number of sources show a rise in traffic safety in urban areas due to a growing share of public transportation. For example, according to UITP,<sup>63</sup> the level of road accidents on light rail transport (LRT) is 0.47 accidents per 1 million passenger-km, in comparison with 2.86 accidents per 1 million passenger-km for motor vehicles within 15 surveyed European cities. That is, light rail transport in cities of developed countries has proven 6 times safer.

The main risk factor for an accident is the driver. For this reason, the greater the capacity of the vehicle, the less the risk of accidents is per one passenger transported provided that the vehicles are filled up within the permissible limits as there are 10-100 times fewer drivers posing a risk of accidents for each passenger. Rail vehicles have significant advantages due to the certainty of the trajectory, no lane changes, which are additional risk factors for accidents. Pedestrian crossing barriers – «labyrinths» - can improve safety (Figure 3.10).

<sup>63</sup> <https://www.uitp.org/news/knowledge-brief-LRT>

**Figure 3.10. Dusseldorf, Germany. Pedestrian crossing barriers provides safe tram line crossing, forcing a pedestrian to look at coming tramway before the line crossing.**



**Figure 3.11. Dusseldorf, Germany. Ramp for grade-separated crossing of bike lane with railroad provides safe and convenient seamless travel for cyclists.**



**Quality of service: accessibility, safety, security, travel time, punctuality, affordability, etc.**

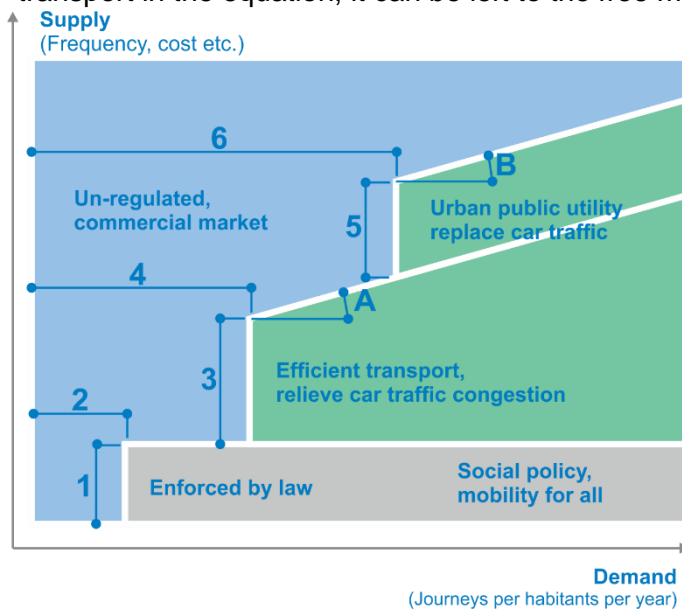
Public transport, in its essence, is a public service. The bigger the number of potential consumers for whom this service is available in terms of the geography, time and price, the greater the benefits of this public transport to society and its efficiency.

With the major role played by public transport in urban life as well as the subsidisation of public transport in most cities of the world, it is well-advised to set the minimum requirements for the



public transport system to meet personally for each consumer based on the principle of equitable distribution of public resources.

The objectives of public transport vary depending on its function in urban transport, as shown in the Figure 3.12. Should there be no political objectives for the development of public transport in the equation, it can be left to the free market to take full control over it.



**Figure 3.12 Possible level of quality standards for transport service given different levels of demand<sup>64</sup>**

To meet the social goals in ensuring mobility for all citizens, levels 1 and 2 must be achieved.

Level 1 is the minimum standard of public transport accessibility which shows the requirements for maximum walking distance, transportation service frequency, transport operating hours for each customer at the place of his or her embarkation (place of residence) and destinations depending on the type of built-up environment, day of the week and year. This social standard must be enshrined in law at an appropriate level.

Level 2 shows the level of demand that derives from a politically established limited number of trips to which each citizen is entitled. When there is minimum demand, the quality standards are ensured by enforcing them through budget funds; however, as demand goes up, an increasing amount of revenues covers the cost for maintaining the quality standard.

In order to meet the goal of reducing vehicle use, the levels of service delivery and demand should switch to values 3 and 4 with 3 standing for the improvement in the quality standard needed to convert a part of the private vehicle users into public transport users. This level depends, among other things, on the conditions of urban car use (congestion, parking fees and street-and-road network passage) as well as on passenger transport fare rates. Level 4 shows the minimum level of demand required to cover the costs for public transport operation in order to manage the quality issue in a way that would compete with the car.

Finally, even more ambitious goals aimed at urban development focused on public transport, yet with no dependence on it, require reaching levels 5 and 6. Level 5 stands for the provision of quality service for all the elements of transport system, 6 stands for the minimum level of demand for this quality level allowing cover the costs of such high-quality service.

The service quality standard is the foundation for designing plans on the development of public transport and route networks. It is this standard that shows a route network developer where the stops should be located in order to ensure pedestrian accessibility to stops from each house, the capacity and frequency of routes required to fill up the rolling stock with passengers no more than the permissible load per 1 m<sup>2</sup> of floor area.

As shown in Figure 3.13, the same passenger flow of 300 passengers per hour can be ensured by either 6 buses circulating at 10-minute intervals with low passenger load, or by 2 buses at 30-minute intervals with passenger overload. In both cases, the passengers are transported but with a fundamentally different level of quality. Also, transport service costs will also differ by 3 times. The quality level selected, and consequently, the cost, hinges on the political choice of cities and regional administrations.

<sup>64</sup> Gustav Nielsen. Public transport — Planning the networks. HiTrans Best practice guide 2 / Guidelines. Skytta, Norway. 2005 — 176 p.

Figure 3.13. Comparison of operating costs at different levels of service quality standards for the same volume of transportation

## 1.High standard

1.Headway 10 minutes

2.Load 1 passenger/m<sup>2</sup>

Expenses: 6 buses on a route



## 2.Low standard:

1.Headway

не более 30 minutes

2.Load 6 passenger/m<sup>2</sup>

Expenses: 2 buses on a route



In the Russian Federation, the Federal Social Standard was adopted in order to provide methodical support for Russian cities and regions. The Social Standard relates to delivering transport services for the population with respect to passenger and luggage transportation by motor vehicles and urban on-ground electric transport. The Standard is of recommendatory nature and serves to show which indicators can be used to measure the public service quality and what level of quality is deemed acceptable for city passengers at the federal level.

The quality indicators of the Social Standard cover the territorial accessibility from stopping points to places (from the boundary line of a place to the nearest stopping point in the street and road network depending on the category of the place). The distance to residential buildings should not be more than 500 metres; accessibility to stops of high traffic frequency main routes should not be more than 1,200 metres in compact residence areas covering not less than 600 people within 1,200 metre walking distance; accessibility to stopping points and rolling stock for people with reduced mobility; price affordability of public transport and other indicators.



**Figure 3.14. Paris, France. Bus stop pavilion has an attractive and practical design, convenient for maintenance. Glass walls provide comfortable waiting area for passengers**



**Figure 3.15. Moscow, Russia. The bus stop is equipped with ticket machine and a display board with actual arrival time**





The fundamental role of the transport service standard is ensured by a social contract related to both the quality and the cost of transport services. The Social Standard enables route network developers to design routes that ensure compliance with the Standard, to calculate the costs necessary for transport network operation as well as to work out the basic tariff required for the operation of the transport system. In justifying expenditures, a fair balance of incomes and an attainable level of expenses must be ensured which allows for adequate financing of transportation for the sake of compliance with technological requirements.

Also, in 2017 the Russian Traffic Regulations were updated with the two new signs restricting entry of motor vehicles according to their environmental class: the "Low emissions zone for freight vehicles" sign, and the "allowed vehicle environmental classes" additional information sign. These will allow to ensure priority of the more environmentally clean vehicles, including working on gas engine fuel. Besides, some measures were taken to subsidize production of the high environmental class vehicles, including working on gas engine fuel. During implementation of the National project "Safe and High-quality Roads" (2020 - 2024), a bus fleet renovation is planned for the 20 biggest urban agglomerations. The allocated funds for the fleet renovations amount to 20 billion RUR, and the new buses working on compressed natural gas will be prioritised.

**Figure 3.16. The new buses of «Volgabus» company working on compressed natural gas in Russia**



### 3.2.2 Principles of PT routes network planning

Planning the transport and route network plays a crucial role in determining the success of the public transport system. The quality of transportation, the proportion of public transport in the overall share of transportation (as a criterion of attractiveness) and operating costs are determined by the following key factors:

- An integrated network of all public transport modes providing for convenient and easy free-of-charge transfers at several stops across the agglomeration;

- Reasonable use of transport modes and rolling stock of necessary capacity to match the passenger flow and required efficiency;
- A simple route network with a clear structure of lines easy for every city resident to understand and to remember;
- Straight route lines ensuring the shortest distances and the highest transportation speed; the latter being achieved by meeting the schedule without fail;
- High frequency of public transport circulation across all routes with a reasonably high passenger flow;
- Coordinated timed schedules for routes with a relatively low passenger flow;
- Efficient main routes through the city centre, local district centres as well as mass interchange hubs connecting the main residential areas and employment areas of the region with the city centre, local district centres and interchange hubs.

Supporting measures (structure of tariffs, fare payment systems, information systems and marketing) in coordination with restrictive measures for private vehicles.

It is important to point out that the model of “pure competition” is not capable of solving the issue of creating quality public transport. However, a state-owned monopolist company is not likely to achieve necessary success, either.

The same experience might turn out to be both successful and have a negative impact depending on the context, objectives of public transport development, local cultural, social and political factors, therefore there is no universal recipe for success.

### **Competition with private vehicles and efficiency as the main criteria for success**

Competitive, high-quality public transport can never be cheap. Normally, public transport systems cannot compete directly with private vehicles in cities; the best-case scenario being that they get to retain their share of transportation in the central parts of cities. A higher share of public transport can only be achieved in areas with high quality public transport integrated with urban planning and combined with restrictive measures on private vehicle use, price incentives for use of public transport, cycling and walking.

### **The objectives of public transport network planning**

When planning a public transport network, the key aspect is to identify the planning objectives and goals, along with the ratio of these objectives and available resources that need to be clearly defined in order to achieve proper execution.

In order to provide transportation to those who are unable to drive private vehicles, it will be sufficient to establish a minimum quality standard for transport service capable of ensuring the transport accessibility to all citizens in the region. Keeping public transport competitive with private vehicles in order to relieve street traffic during peak hours may become a more ambitious goal. However, the idea of creating high-quality public transport capable of replacing private vehicles in cities on a permanent basis in order to shape an environment more attractive for life is an even more ambitious goal.

### **Definition of the transport network structure**

The idea of public transport is to serve several persons per vehicle for less generalized cost (direct expenses and externalities like pollution, accidents, time spent, etc). The larger amount of people per vehicle – the closer is the goal (reduction of generalized costs). The basic principle of public transport is the concentration of passenger flows along a small number of routes, so as to achieve larger loads per vehicles, while keeping the reasonable headways (about 10 minutes or less). Transfers are an integral feature of a large share of routes. Therefore, the ways of managing transfers and transport services make up the “core” of the strategy of improving public transport.

It is advisable to start the planning off with an analysis of the strengths and weaknesses of the existing network, to study the situation as viewed by different groups of customers, as well as

to analyse the network from the point of view of the provider. Thereafter the target network should be identified for the long term. Once this is over, short-term solutions must be worked out. The following structure of work may be considered:

- Infrastructure issues and major high-demand corridors are the ones to be started with.
- The main transport corridors should be provided with as few routes as possible by introducing main (frequent) routes connecting the outskirts through the city centre along the main transport corridors;
- Possible tangential and link routes or corridors that can be serviced together with radial routes have to be planned out in such a way as to form a more complete network servicing the region, with due regard to route integration through convenient transfers;
- Both the urban and regional (agglomeration) route networks should be planned in order to achieve the best combination of routes both for passengers and providers. This can be realised through an integrated system of tariffs (trips should be available within the city along suburban routes using all citywide tickets without limitations);
- A timed schedule (with equal intervals that divided by 60 minutes) on routes with low traffic should be ensured.

### **Understanding the role of planning in different institutional environments**

Successful planning requires studying the organisational structure of transport management, stakeholder interaction, demand for public transport services and changes in the sector.

First of all, it is necessary to understand the imperfections of the market mechanism in relation to public transport. The theory and practice of high quality public transport clearly demonstrate the need for its centralized planning over a city.

Secondly, the extent of planification depends on the degree of transportation regulation in a particular region. In approaching public transport as a public service, the role of planning becomes significantly more important compared to regions where public transport is viewed as a “free market”.

Thirdly, the best practice, as has been proven, is to combine the benefits of integrated planning with the advantages of market competition “off-the-route” (the competition should be for the right to run a route without any competition on the route itself). The advantages of the market approach can be gained by bids held to run routes as well as to develop and service the respective infrastructure.

The following institutional factors are essential successful public transport planning:

- All large regions with a robust public transport system in place are ones with a strong regional governing body that integrates public transport into a single regional network;
- There are various patterns of regional transport management that have proven to be viable;
- A sustainable public stance on financing the public transport is a prerequisite for quality public transport;
- Providers need economic incentives which can come in different forms;
- Organisational measures are known to play a significant role;
- A strategy of drawing customers to transport services, and promotion of transport services among customers can also do the trick;
- Cooperation with policy-makers across political lines outside the transport field is of great import.

### **Capitalising on the synergy of the network effect**

To achieve long-term success, public transport should be the "main locomotive" of urban development steadily ensuring high quality year by year. This stability is indispensable for the public transport to influence the developers' initiatives, and to give momentum to the development of new districts. The new districts, in their turn, reciprocate by encouraging the use of public transport.

In order to compete with the private vehicle sector in an urban environment in successful manner, two key qualities of public transport are needed: minimum waiting time for public transport and an integrated network of routes servicing all points with high demand for transport. Intervals on the main routes should be from 5 to 10 minutes: this will allow most customers to “forget about the schedule” thus reducing the waiting time.

With a high passenger flow, the capacity of standard buses may not be enough. Under such circumstances, the capacity of vehicles en route must be enhanced coupled with the development of rail transport.

### **Combining network structure stability and adaptability to changing conditions**

The public transport system should have the potential to adapt to shifts in demand taking into account the changes in built-up areas and land use, changes in the nature of employment, housing and other places of passenger attraction. That being the case, the long-term stability of high-quality networks is essential to creating a positive impact on developing the adjacent areas and setting up sustainable transport links. Public transport resources should be focused on servicing major transport corridors in order to be a decent rival to private vehicles. However, such concentration may contradict the need to ensure equal access to public transport for all citizens.

The influence of rail infrastructure on the development of adjacent territories can be well traced in world practice. Stability requires some flexibility and readiness to be developed, in particular, with the adjacent territories developing, the route network should have the potential to be extended to the newly developed territories without major changes. Such adaptability is possible when building a system based on as few simple and easily identifiable lines as possible. A network comprising a small number of simple routes has significant advantages over complex networks, allowing customers to easily memorise the network structure, which is critical to the attractiveness of public transport.

The network should be able to adapt to changing loads, especially to growing passenger loads. Optimal intervals of traffic on the route network cannot be planned for years ahead. Generally, transportation intervals and rolling stock capacity are planned for 1-2 years ahead based on the continuous monitoring of the passenger flow, while more long-term forecasts are required as the grounds for construction of a new transport infrastructure and determining the network basic structure to make it adapt better to the future conditions, including with due regard for transport mode preferences. LRT has excellent adaptive ability: the capacity of the rolling stock and carrying capacity can be incrementally increased from 1,000 up to 15 -18,000 passengers per hour without having to restructure the infrastructure. In particular, the decision to develop transportation in Ottawa (Canada) through dedicated lines for high-speed buses led to these lines overloading and the inability of the bus to cope with the growing number of passengers which resulted in the need to re-structure the bus system into a system for light rail transport.

In regions with limited demand (usually regions with low population density), it is necessary to introduce feeder routes to the main line network (mostly ones leading to rail stations and stops).

### **Network effect<sup>65</sup>:**

Regardless of demand elasticity and service frequency being interdependent in an intricate way, doubling the traffic frequency along the route will lead to traffic growth by only 20 - 50%, that is, the additional revenue will never cover the increased costs on a particular route. The effects generated by an increased traffic frequency are primarily indirect and associated with a reduction in travel time for the population and decreased vehicle use. These benefits should be covered by public resources (budget funds) as they may not be covered by the gain in ticket revenues.

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<sup>65</sup> HiTrans Best Practice Guide. 2. Public transport — planning the networks. Gustav Nielsen, et al. HiTrans, 2005



The fundamental impact of the frequency of public transport circulation manifests itself in the so-called *network effect*, where an increase in the frequency of all public transport routes leads to synergy along with an overall boost in the appeal of public transport.

### **3.2.3 Principles of PT mode choice and organisation of its operation**

The choice of the appropriate mode of transport is determined by the economy behind the transport system, technological requirements and the quality standard of transport service.

According to the calculation performed in the context of one Russian city with a population of over 600,000 residents, at least 91 minibuses, 34 medium-capacity buses, 22 high-capacity buses and 11 articulated trams (27 m) are required in order for a passenger flow of over 2,000 passengers per hour to be serviced with the capacity of transport vehicles calculated as per the standard of 4 persons/m<sup>2</sup> of free floor area (Figure 3.17). The high frequency of bus traffic requires a dedicated lane whose costs must also be taken into account.

Given the costs associated with drivers' salaries, repairs and depreciation of rolling stock and infrastructure, tram transportation appears to be the most economical option in this case. The calculation indicates that transportation by high-capacity buses will be 38% more expensive than transportation by tram, transportation by medium-capacity buses will be 89% more expensive than transportation by tram, transportation by small-capacity buses will be 3,37 times more expensive than transportation by tram. The economic advantages of large and extra-large capacity transport vehicles are achieved by a manifold gain in the labour efficiency of drivers without operating costs substantially increasing. It is obvious that this calculation is fair when the rolling stock is filled up to the extent close to standard load. The task of the transport planner is to select the rolling stock and intervals in such a way so that all vehicles are filled up to the extent as close as possible to the permissible load density during peak hours but without exceeding it.

**Figure 3.17 A comparative calculation of managing transport services on a 10-km route with a passenger flow of at least 2,000 passengers per hour in one direction<sup>66</sup>**

№	Indicator (with equal conditions of remuneration of labour and taxation)	Vehicle capacity				
		Low (Ford-Transit)	Medium (PAZ Vector); a fare inspector included	High (LIAZ 5256); a fare inspector included	High (LIAZ 5256); no fare inspector	Very high (Vityaz tram)
1	2	3	4	5	6	7
1	Capacity, persons	22	60	90	90	188
2	Traffic frequency (the number of departures from a station per hour) to service a flow of passengers of 2,000 persons per hour	91	34	22	22	113
3	Required fleet of rolling stock to service a route of 10 km at a given frequency	180	57	33	33	14
4	Rolling stock depreciation costs (including service life), mln. rubles per year	86	33	47	47	28
5	Expenses on drivers (and fare inspectors for medium-capacity and high-capacity buses) mln. rubles per year	183	89	51	33	14
6	Fuel and energy, mln. rubles per year	49	38	33	33	24
7	Rolling stock repair costs, mln. rubles per year	115	69	46	46	32
8	Infrastructure costs (maintenance and repair of a 3.5-m dedicated lane, tramway, energy)	30	30	30	30	40
9	IN TOTAL: the maintenance costs of a 10-km route with a flow of 2,000 people per hour by mode of transport, mln. rubles per year	462	259	207	189	137
10	Cost-to-minimum ratio (tram)	3.37	1.89	1.51	1.38	1.00

When choosing the mode of transport, the main criterion technology-wise should be the maximum capacity of transport modes. With a passenger flow of more than 3,900-4,000 passengers per hour, the frequency of extra-large capacity buses will exceed 30 vehicles per hour, which will not allow for stable conditions for transportation through intersections at the same level. With the passenger flow that high, the use of rail transport is dictated by the technological conditions.

Apart from the capacity criterion, another engineering requirement is room left for passengers with reduced mobility to be seated (passengers with prams, disabled people, passengers with bicycles, etc.). Generally, small-capacity buses are not technologically capable of accommodating passengers travelling with prams and therefore it is recommended to use at least medium-capacity vehicles equipped with a low-floor platform for the convenience of persons with reduced mobility. It is advisable to avoid the use of vehicle-built-in ramps and other special devices intended for pickup of low-mobility passengers, since their use significantly increases the embarkation time causing delays in the schedule as well as overload the rolling stock. The infrastructure (landing platforms) must be fitted up in the proper way (Figure 3.18).

<sup>66</sup> According to data obtained by IEC (Infrastructure Economics Centre) in the Russian Federation, <http://infraeconomy.com/en/>.

**Figure 3.18. Paris, France. All the tramway stops are equipped with the platforms, levelled with the vehicle floor, allowing not only the convenient access for everybody, but also reducing the boarding time at every stop. Every platform has spacial waiting area with enough width and seats. The typical stop is equipped with informational table, providing information on waiting time for routes served**



Environmental requirements encourage the gradual transition to electric transport, that is the tram, trolleybus, electric bus, and urban electric railway.

Requirements aimed at reducing the number of road accidents and the mortality rate resultant therefrom, along with the demand to curb direct costs, lead to the largest-capacity transport vehicles being recommended for operation with a view to cut down the number of vehicles engaged in transportation. In planning a network, a balance must be struck between increasing capacity and maintaining acceptable intervals. For example, with a capacity of 188 persons per one tramcar and a passenger flow of 188 passengers per hour, the tram, if selected as the appropriate mode of transport with adherence to the requirement to meet the standard passenger load, will result in traffic intervals of one hour, which is inadmissible from the perspective of service quality. The job of the transport planner is to establish the maximum possible capacity at acceptable traffic intervals (usually not more than 10 minutes during peak hours). The optimal solution is to select the capacity of rolling stock, at which the interval of transportation is kept down to no more than 10 minutes during the whole day, shrinking to possibly 6-8 minutes at peak periods.

In order to ensure that vehicles of the largest capacity are filled up with passengers as per the standard at reasonable intervals (about 8 minutes during peak hours), a high concentration of passenger flow must be achieved on a small number of routes by reducing the overall number of routes. In this regard, the transport systems in German, Swiss, Austrian or some other countries' cities have no more than 1-2 routes per street, which consequently helps ensure that large and extra-large capacity vehicles are filled up in conformity with the applicable passenger density standard while also saving costs for transport services.

### 3.2.4 The interactions between different modes of urban transport

The quality of transfers between routes and modes of transport is critical for building up a public transport network that is competitive with private cars in cities. The difference in travel time, journey comfort and orientation convenience between well-placed and misplaced transit stations is truly significant.

High-quality transfers, which may be potentially required in a greater number of intersections are necessary to shape a network effect that would maximise the benefits of a simple but efficient route network with a small number of high frequency routes. Inadequate quality of transfers requires extra direct routes with less traffic frequency which results in a route network that is fragmented, difficult to perceive and constantly changing.

**Figure 3.19. Dusseldorf, Germany. Cross-platform transfer between bus and tramway provides most safe and fast transfer, allows to remove excessive routes and rise the route network efficiency**



The greatest network effect can be attained by introducing convenient transfers at all the intersection points of two or more routes for the purpose of creating new transportation capabilities. Most of such intersections are ordinary crossroads, it is therefore important that traffic is designed to be managed with a focus on the priority of convenient transfers for passengers. In particular, this is achieved through the physical proximity of stopping points to crossroads and to each other with the shortest distance between them (from vehicle door to vehicle door), as well as, if possible, arrivals of transport vehicles common stopping station at intersections (Figure 3.19).

Large interchange hubs serve to connect the urban space with the transport system. These are regional and local activity centres, which provide for transfers while also being major places of attraction for passenger flows. These hubs are often located within areas of employment, commercial activity and public service and, in some cases, areas of high population density.

The quality of the transportation chain depends on the quality of the weakest link. In this regard, the walking distance to stopping points should also be factored in as a component of the public transport system. The walking distance should be as short as possible, which is partially achieved by stopping points located efficiently as well as by a comfortable network of pedestrian paths illuminated and protected from dirt and noise going through an attractive



urban environment. The more attractive the pedestrian route is, the greater the distance that pedestrians are inclined to walk.

At rail/bus crossings over the bridges, the upper level bus/tramway/rail stop should be provided exactly on the bridge above the crossing, and the below level stop – just below the bridge, so as to provide the shortest walking distance possible, with the lifts (and escalators – upstairs, und downstairs on busy stations) connecting the levels in all possible transfer directions. Use of stairs and long panduses should be minimized and replaced with lifts and escalators (Figures 3.20, 3.21, 3.31). Transfer shortest paths are usually more important, then shortest connection to surrounding area, due to increased amounts of people wishing to transfer then to start/end their journey here (Figures 3.22, 3.29, 3.30).

The best type of interchange is cross-platform interchange, when the vehicles stop at the both sides of the same platform (Figure 3.18). In order to achive this, some gound transit routes in Toronto, Boston, Valencia and other cities routed underground, to provide cross-platform interchange with subway (Figures 3.26, 3.27). The other means to make an interchange convenient and shortes-path, is to concentrate all the routes under the same shelter, e.g. routing tramway line into the station building (Figures 3.22-3.25, 3.28).

**Figure 3.20. Dusseldorf, Germany. Escalators are connecting street level with underground pedestrian space to provide the most convenient pedestrian route**



**Figure 3.21. St Petersburg, Russia. The new transit hubs are equipped with escalators going to street level, providing the attractiveness for passengers**



**Figure 3.22. Geneva, Switzerland. Transit hub at rail terminal provides the shortest walking path between all means of transport (rail, tramway, trolleybus, bus, taxi). The tramway and trolleybus stops are arranged just inside the rail crossing tunnel.**





**Figure 3.23. St Petersburg, Russia. Ladozhsky rail terminal is a good example of transit hub, integrating intercity rail, subway, tram and ground transit in the same hub building. Walking distances between the modes are shortest possible**



**Figure 3.24. St Petersburg, Russia. Passengers can transfer between all modes in the same terminal building. This is comfortable in rainy and snowy days**





**Figure 3.25. Geneva, Switzerland. Geneva Airport provides convenient and short walking distances between the terminal and all the other modes (intercity rail, trolleybus and bus lines)**



**Figure 3.26. Toronto, Canada. Tramway lines are integrated with underground subway stations so as to provide the shortest and comfortable transfer walkways between two rail modes.**





**Figure 3.27. Toronto, Canada. Tramway line ramp for the underground station in order to provide the most direct connection with the subway station.**



**Figure 3.28. Toronto, Canada. Tramway line built to the subway station building, so as to provide the shortest and comfortable transfer.**





**Figure 3.29. Moscow, Russia. Transit hub at Kutuzovskaya integrates subway, urban rail, bus and trolleybus routes with the shortest walking distances possible. The bus stop is placed directly at the bridge over the rail line in front of the station entrance.**



**Figure 3.30. Dusseldorf, Germany. Tramway stop is placed on the railway bridge in order to minimize walking distance at transfer.**



**Figure 3.31. Installation of escalators and waiting halls in railway stations in a similar manner to metro stations as part of the efforts aimed at the integration of railway transport into the public transport system of Moscow (Russia)**



For larger cities and metropolises there is usually need for higher capacity public transportation service. With a rich 20th century rail heritage, urban rail services are here to help. One of the best examples – Moscow Central Circle which was opened in 2016 in Moscow using an existing 54-km railway loop which was used exclusively for freight operations. Payment modes are the same as on other types of city public transportation. Although considered as 14-th Moscow Metro line, it is a fine example of “classic” urban heavy rail service.

Tram-train is a light rail mode of transportation that has its own separate rail infrastructure inside several cities of an agglomeration and shared heavy rail infrastructure between them. This mode of transportation shares the advantages of both heavy and light rail systems: capacity, safety, accessibility to the cities’ very centers, but without necessity to construct separate track between the cities of an agglomeration.

Usage of tram-train systems is quite popular in Germany and Switzerland with vast urbanized areas of high- and mid-density development. Such “hybrid” modes would be in demand in polycentric agglomerations with distance between cities no more than 30-50 km. Implementing such systems might require some changes in national technical standards, as it might be forbidden for light rail rolling stock to use heavy rail infrastructure even if compatible with heavy rail signaling systems.

Cycling can drastically reduce travel time in areas with less population density located more than hundred metres away from stops. The speed of cycling is 3-4 times higher than that of walking. This means that there will be 10 times more areas (and places) within the same time range for cyclers than for pedestrians. Convenient bike access routes to public transport stops will add to the appeal of combined “bike-bus” and “bike-train” trips. It is important to fit up railway stations, tram and bus stops with parking spaces for bicycles.

Private vehicle access to public transport is a common solution for low population density areas located at a distance from public transport stops. There are two practices to achieving that known in the world:

- Park & ride: A driver and accompanying passengers leave their private vehicle on a parking lot and continue with their trip by public transport;
- Kiss & ride (drop-off at public transport stops): a fellow traveller drives a over passenger to a public transport stop or meets him or her at a stop in his or her private vehicle.

The efficiency of park-and-rides is dependent on the traffic frequency on the route, the transportation speed and the proximity of parking space from public transport vehicles taking into account the fee of park-and-rides in comparison with the parking fees in the city centre.

A park-and-ride can be free of charge (with the fee included in the ticket price) provided that there are practically no other buildings in the surrounding area that made accessible by it. Free parking is inadvisable in cases where there is high demand for parking in the area adjacent to a PT station (which often is the case near railway and metro stations): in this instance, a more effective solution would be to locate office, business or residential buildings in the immediate vicinity of a PT station.

### 3.2.5 Specific issues of urban public electric transport development

Urban public electric transport in many countries has traditionally been seen as being separate from bus transport because of both its linkage to infrastructure and general service technologies that are fundamentally different from the diesel transport technologies.

It should be noted that a simplified view of transport modes as being strictly separated impedes the integration of transport modes into a single system. Ultimately, it is time saving, safety, environmental friendliness and cost affordability that are of the utmost concern to the passenger, the final effects of the transport system operation, rather than the specific type of engine or the name of transport mode. For example, the metro, the urban railway and the tram came to be as a single mode of transport, but due to departmental disunity they were gradually divided, generating a disintegration and causing unnecessary transfers. In our day and age, this disunity can be eliminated by the reverse integration of transport modes, for example, by constructing tunnels and underground stations for rail transport and the tram similar to the metro, by introducing unified ticket for all the modes for 90-minute journey with unlimited transfers (with prohibition of tickets and tariffs “by transport mode” or “by vehicle entrance”) as well as delivering high-frequency service on all the rail modes, a successful example of which is the Moscow Central Circle which ensures intra-city railway transportation with intervals of 5 minutes with tickets shared with the metro (with free transfers between the both modes). The system operates during the day and integrates rail transport into citywide transport to serve as an interchange hub to facilitate transfers.

The modern world practice (for instance, the practice of the International Association of Public Transport, <http://mapget.ru>) views the trolleybus as an electric type of bus while increasingly regarding the tram (light rail transport, LRT) as metro. The type of traction (electric, diesel, etc) operated takes a backseat to the track structure, i.e. the extent to which the public transport line is segregated from the road traffic. Surveys<sup>67</sup> demonstrate that urban on-ground public electric transport is perceived by the population as more attractive when compared to traditional busses, especially when operated within a dedicated infrastructure while meeting high transport service quality standards. This leads to reduced use of privately owned vehicles as well as easing the burden on the street and road network.

The conventional bus - trolleybus division is effaced with the introduction of an electric bus, that is a trolleybus with autonomous capabilities. In order for the electric bus to run, it needs to pass approximately 20-25% of the route under the contact wire to have sufficient time to charge. As a result, a significant part of the bus routes in any city with a trolleybus network can be converted into electric buses without any additional cost.

Electric traction provides the following significant advantages as opposed to diesel operation:

- zero exhaust (no air pollution) en route and at stopping points (Figure 3.32);
- noiseless operation (minimum noise level possible);
- lower vibrations in the cabin;
- energy saving (minimum energy consumption);
- smooth acceleration and braking, no gearshift;
- maximum engine thrust at any speed;
- increased reliability of transport vehicles;
- no engines running at idle speed;
- low operation costs;
- high attractiveness for the population;
- reduced private motor vehicle use; less pressure on roads due to the higher quality of trips.

These advantages encourage cities to transition to electric motor transport vehicles, including public transport.

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<sup>67</sup> Journal “Tekhnika zheleznikh dorog” (Railway Engineering), No. 4 (36), by S.S. Zakirova, V.A. Matrosova, E.V. Matveeva “The situation with urban electric transport in Russia”.



The use of electricity in urban transport is an effective solution to the problems of emissions of pollutants and climate gases. While electricity is generated at thermal power plants, the discharged pollutants are captured and neutralized at a stationary emission source (a power plant pipe), which is incomparably more effective than combating the emissions from hundreds of thousands of mobile sources (cars).

**Figure 3.32. Schaffhausen, Switzerland. The parliament voted to preserve trolleybus operation in this small town due to ecological reasons.**



In cities where passenger traffic is under 500 passengers per hour, building a trolleybus line is not economically viable, so the largest number of urban and agglomeration routes remain covered by busses – mainly electric buses, powered by contact wire, but able to come out of the wire to serve the surroundings. With a passenger traffic from 500 to 1.000-1.500 passengers per hour, a trolleybus line becomes an optimum viable option. A higher passenger traffic calls for a tram line. If the passenger traffic is higher than 18.000 passengers per hour, the section of the tram line should have no crossings in the same level (a flyover or a tunnel)<sup>68</sup>. As compared to road transport, rail transport has several advantages<sup>69</sup>:

- higher carrying capacity;
- reduced amount of land required to transfer passengers;
- less energy consumption (due to reduced friction in motion);
- less need for staff per passenger;
- lower operating costs (owing to less staff and energy consumption);
- no emissions from the wear of tires and pavement;
- no other vehicles on the dedicated line (owing to the railway-design track);

<sup>68</sup> Journal "Tekhnika zheleznikh dorog" (Railway Engineering), No. 4 (36), by S.S. Zakirova, V.A. Matrosova, E.V. Matveeva "The situation with urban electric transport in Russia".

<sup>69</sup> <http://mapget.ru/strategy/rol-get/>

- higher traffic safety (less manoeuvres, no others vehicles on the road, ~ 4 time less accidents per passenger).

Throughout the UNECE region, tramway face a rebirth, which is not new but now widespread. In the Western of Europe, the development of tramways was relaunched in the 1980's in cities such as Nantes, Grenoble or Strasbourg in France, the Eastern part of Europe is also witnessing similar changes and cities which still operate old trams such as Bucarest in Romania are actively looking for modern replacement solutions. Meanwhile in the Russian Federation starting with Moscow which plans to renovate over 60km of tram line by 2020<sup>70</sup>, many large cities have engaged in tram redevelopment and modernization. In Azerbaijan, Baku is likely to also develop a new tram network.

In some cases, trams can have a similar impact on urban development than railways and serve as a catalyst for transit oriented development or, in that case, we could say tram oriented development. In Basel (Switzerland). A new neighbourhood with around 5'000 workplaces was developed on the former factory site of Klybeck. Additionally, 10'000 people will live there in the future. The neighbourhood was developed thanks to a new tram connection known as Tram Klybeck, something that was integrated in early stage urban planning<sup>71</sup>. This goes with the development of a comprehensive tram-based MRT system at city, canton and tri-nation wide scale led by the Tram Network Region Basel 2020. In less than a decade, this integrated mobility and development policy, connected to the large scale urban innovation project IBA Basel connecting Switzerland, Germany and France has proved to be an efficient catalyst of sustainable urban development.

Several thousands of kilometres away from Basel, in central Asia, Uzbekistan is considering redeveloping trams, such as in Samarkand, the country's second largest city which follows a plan to develop intermodality and transit-oriented development.

**Kazan (Russia)**<sup>72</sup>: Pursuant to the principles of transport system sustainable development, the city of Kazan is contributing to the development of urban on-ground electric transport, including by creating a support tram network, maintaining and developing a trolleybus network, renewing the rolling stock of trolleybuses and trams.

The most common method used to ensure high reliability and speed in Kazan (as in many cities in the UNECE region) is to segregate routes of communication, including by physical isolation of tram tracks and introduction of dedicated lanes for road traffic. The introduction of priority public transport lanes in the main streets thereby establishing transport links between the residential areas and the city centre and the streets with access to external roadways.

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<sup>70</sup> According to the response of Moscow (Russia) to the UNECE questionnaire.

<sup>71</sup> Based on the answers given by Basel (Switzerland) to the UNECE questionnaire. [www.klybeckplus.ch](http://www.klybeckplus.ch)

<sup>72</sup> Based on the answers given by Kazan (Russia) to the UNECE questionnaire.



**Figure 3.33** The city of Kazan (Russia) is contributing to the development of modern tramway to the new housing.



While the use of electric transport may have been earlier constrained by the need to develop the power network infrastructure, now, thanks to the development of autonomous trolleybuses, diesel buses can be substituted en masse with electric buses (buses dynamically charged by the contact network) requiring no significant investments (except for increasing the capacity of substations if needed).

Electricity rate regulation for urban electric transport (tram, trolleybus, metro) is an essential issue related to promoting the development of electric transport for passenger transportation. Today, in a number of countries, for example, in the Russian Federation, power for electric transport enterprises is supplied at rates similar to those offered for industrial enterprises, taking into account maximum power consumption costs. Although such rates are proven to effectively balance consumption peaks for the industry, it is not the case for urban electric transport, as consumption peaks are an objective attribute of urban transport. It should be mentioned that fuel for bus transport is supplied at the same preferential prices as for the general public, which, therefore, can be construed as a disguised subsidy for the less efficient and less environmentally friendly mode of bus transport to the detriment of the development of urban electric transport. Given that the only end user of urban electric transport is the population and the role of urban transport is a life support system, the introduction of special reduced electricity rates for urban electric transport seems well-advised, for example, by setting electricity rates for urban electric transport at the same levels as for the population. Such measures have already been applied in some countries, such as Ukraine.

In recent years, there has been a trend towards excessive stimulation of private electric vehicles use. The largest efforts have been made in Sweden, where electric vehicle owners, along with the available significant discounts on the purchase of an electric car, have been granted free parking as well as dedicated public transport lanes. The final effect of excessive stimulation of private electric vehicle use has turned out to be negative: public transport has lost its advantages on the dedicated lanes as they have, too, come to be overwhelmed with traffic, the attractiveness of private vehicle trips has improved significantly, resulting in higher

vehicle use and its adverse consequences — environmental pollution (for example: tire tread friction), road accidents and traffic congestion. The means that measures taken to promote electromobility while being generally effective in mitigating the environmental impact should under no circumstances encroach on the priorities of public transport over private vehicles.

### The specific question of electric buses

The impressive deployment of electric buses in China has recently at the centre of attention. While globally, the sales of electric buses rose up to 370.000 in 2017 from 345.000 in 2016, (while the number of electric two-wheeled vehicles reached the 250.000.000 mark) China accounted for more than 99% of mobile vehicles in these two segments. This is because impressive state subsidies in China, making the electric bus purchase more attractive, than diesel, despite the significantly higher cost of an electric bus. However, UNECE countries, along with India have demonstrated an increase in the fleet of electric buses.

Statistics show that the European market is quickly ramping up. In 2017, the number of electric bus orders more than doubled (from 400 in 2016 to more than 1,000). In the coming years, manufacturers are expected to continue scale up their production and diversify their products. In 2018, the market share of electric buses was estimated at around 9%, marking the transition from niche to a more mainstream and the beginning of a steep and necessary uptake curve.

In principle, electric buses offer many additional benefits compared to their fossil counterparts. They have superior image and comfort, avoid stranded assets from investing in gas infrastructure, use locally produced (renewable) energy and ensure energy sovereignty by displacing oil consumption. The bottom line is clear, the earlier cities transition to a zero-emission bus fleet, the better. To expedite this transition, cities, procurement authority and public transport operators need to:

- Embrace the future and start to procure electric buses en masse to replace their aging and polluting fleets and to live up to some of the century's biggest challenges.
- Communicate to manufacturers urging them to ramp up scale of production which in turn would reduce prices.
- Have a TCO-focused approach by shifting from upfront payments to lease or loan payments aligned with the durability of the asset over a long period of time.
- Include external costs in the tendering process when comparing different options.
- Seek and encourage new financing mechanisms from traditional funding institutions.

**Figure 3.34 Promotion of electric bus in Moscow and demonstration of autonomous bus parking in Paris**

In practice, the situation is different. Replacing huge bus fleets with electric vehicles will take time and



cost money, an investment that transportation companies and local governments alone might not be able to support without national and international additional funding. The pace of development of electric buses fleets depends on operators' investments plans. Although the issue is more complex than technological change, the competition between transportation companies is intense, involving a lot of communication. Electric busses in Moscow are fitted up with the most advanced equipment, including climate control systems, video surveillance and satellite navigation, USB connectors for charging mobile devices and access to Wi-Fi<sup>73</sup>. In Paris, RATP, the company operating public transportation, has recently (April 2019) introduced

<sup>73</sup> According to the response of Moscow (Russia) to the UNECE questionnaire.



experimental autonomous parking systems in buses depots while developing a fleet of hybrid vehicles.

The most efficient and recommended charging option for electric bus is the contact wire lane (“dynamic charging”). The problem with charging in electric buses which charge statically is the electrical contact area which limits the current and battery charging speed: the energy transferred to the battery per unit of time is currently about 100 times lower as compared to the energy a classic diesel-fuelled bus receives over the same period of time. Therefore, every 20-30 km, a typical distance for turnaround trips in major cities, the electric bus requires at least 10-15 minutes of net charging time at the final stations (excluding the separate spare time for late arrivals used up whenever a vehicle arrives behind schedule). This means that each hour of a turnaround journey involves at least 10 minutes of downtime which adds to the need for more rolling stock en route (and more drivers), as well as driving up the costs of running the route by 15-16%. The figure below shows an example of a comparative calculation of managing transport services on a route of 10 km in length with a passenger flow of at least 2,000 passengers per hour in one direction, which typical of cities with a population higher than 500.000 people in Russia.

Extending the autonomous operation of electric vehicles entails an increase in the dimensions of batteries and higher rolling stock prices so the charging process at the final station also results in an increase in the cost of each rolling stock unit.

In view of the strengths of dynamic recharging, a number of cities have decided to restore the trolleybus contact network: for example, Prague (Czech Republic) has already built a contact network section to provide dynamic charging for the electric bus route with similar plans announced for Berlin and Dresden (Germany).

**Electric buses in Warsaw (Poland)<sup>74</sup>: purchase of bus stock (130 low-floor, low-emission buses) with associated infrastructure:** The Warsaw electric buses project includes: replacement of 10% of the vehicle stock of Warsaw MZA municipal bus operator with 18m articulated electric buses; and creating associated infrastructure, including the construction of aerial chargers at the ends of selected bus lines, and the adaptation of bus depots. In the long run the project will assist the Poland-wide trend towards electric mobility, limiting risks related to CO2 emissions generated by fossil fuels consumed in the transportation sector worldwide. The project is supported by co-financing from the Polish Operational Programme "Infrastructure and Environment", which distributes EU assistance funds. The total cost of the project will amount to 89.5 million USD, including external financing of 47.5 million USD. The remaining 42 million USD will be covered by the applicant – MZA bus operator, which is a municipal company 100% controlled by the City of Warsaw. Public opinion in Poland is still mostly wary of electric mobility, considering expensive electric vehicles to be something of a waste of money. However, passengers were positive about the electric buses that went into operation in Warsaw even before the current project began. They appreciated the noise reduction provided by such vehicles and the lack of pollutants generated by their propulsion systems. Key impact: within the duration of the project, the avoided emissions of non-methane volatile organic compound will amount to 20,987t/year. The avoided emissions of NOx will equal 124,133t/year, while of SO2 – 49,407t/year and of PM2.5 – 0.139 t/year. The combined avoided emissions for 10 years of bus LCC would amount to: 209,87t of NVMOC, 1,241,33t of NOx, 494,07t of SO2 and 1,39t of PM 2.5.

**Cities implementing some of the largest electric bus fleets in Europe<sup>75</sup>:**

**Brussels, Belgium:** The public transport operator in Brussels (STIB/MIVB) operates 7 ‘midibus’, 5 standard and 25 articulated busses, using overnight depot charging and opportunity charging at depots and in the city centre. Currently these buses (of 2 different busmakers) are running in commercial service on 4 lines.

<sup>74</sup> [https://www.c40.org/case\\_studies/warsaw-electric-buses-2017](https://www.c40.org/case_studies/warsaw-electric-buses-2017), C40 CITIES, 2018.

<sup>75</sup> <https://www.uitp.org/events/training-and-study-tour-electric-buses>, UITP (Union Internationale des Transports Publics), 2019.

**Geneva, Switzerland:** Geneva’s public transport operator (TPG) operates a fully electric bus line using the TOSA concept (Trolleybus optimisation système alimentation) which is composed of opportunity and flash-charging infrastructure installed at line ends and along the line corridor. It allows an efficient electric bus operations without the constraints of long depot charging. Furthermore the existence of a large trolleybus and tramway network makes it an interesting synergy example from the point of view of electrical infrastructure.

**Paris, France:** The public transport operator in Paris (RATP) currently operates a fleet of 85 electric buses with 77 more e-buses to be operational by October 2019. Particularly interesting is the reorganisation of the workshops and depots necessary to a smooth integration of this new fleet. Furthermore, with an order of more than 800 more electric buses, Paris will be a leading city in Europe in scaling up the electrification of the city’s bus fleet.

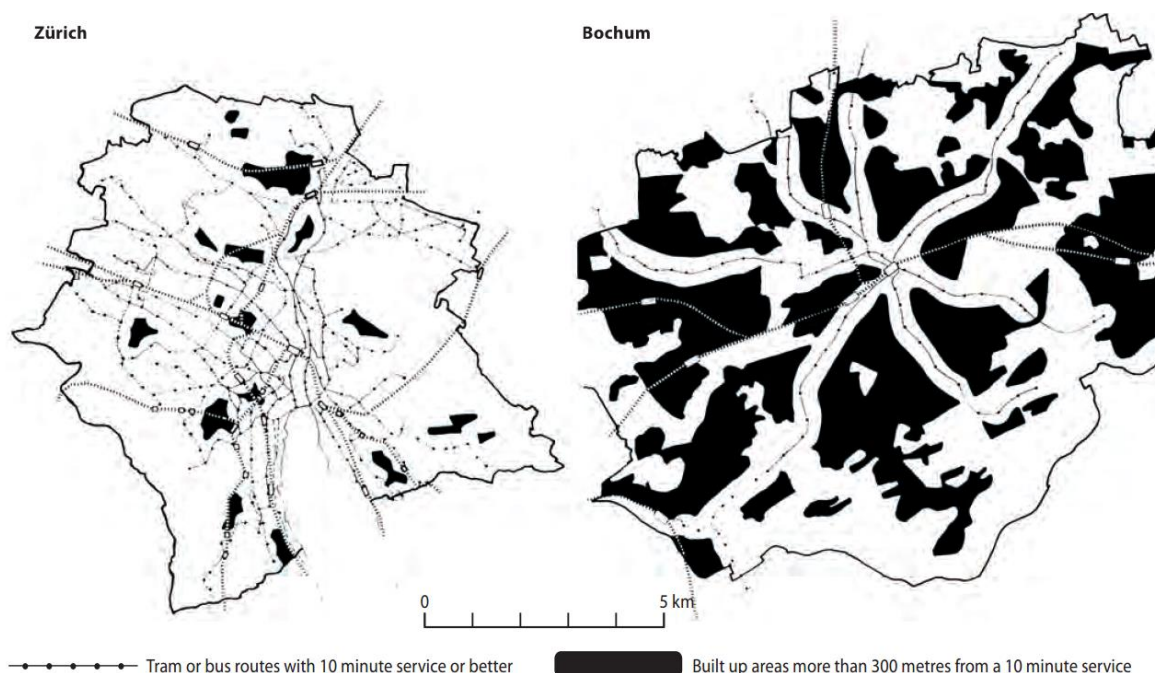
**Namur, Belgium:** the public transport operator in Wallonia (TEC) runs a large fleet of 46 plug-in hybrid electric standard buses (PHEV) in the city of Namur. The buses are operating in a zero-emission mode in urban environments and switch to diesel for regional and inter-urban operations, making it an interesting use case for small and medium sized cities.

### 3.2.6 Case studies and good practices

Case studies and good practices in public transport planning, financing and management are given below.

An analysis of the Zurich route network showed that the key factors in the appeal of public transport in Zurich are the high density of the route network and high traffic frequency. A comparison of the zones accessible on foot in Zurich and Bochum (Fig. 3.35) shows that Zurich has a significantly higher density of transport services, where more than half of the tram and bus routes operate at an interval of 6 minutes with this level of service maintained for 100 years. Zones outside the 300-metre walking distance from PT stops in Zurich serviced at intervals of no more than 10 minutes occupy a miniscule share within the city while in a typical European city such zones account for a significant proportion.

**Figure 3.35. Comparison of PT accessibility in Zurich and Bochum (Switzerland)<sup>76</sup>**



<sup>76</sup> HiTrans Best Practice Guide. 2. Public transport — planning the networks. Gustav Nielsen, et al. HiTrans, 2005.

A comparison of service density shows that the service area of Zurich is about 3 times bigger than that of Bochum.

**Figure 3.36. Comparison of service density indicators of public transport in Zurich and Bochum (Switzerland)<sup>77</sup>**

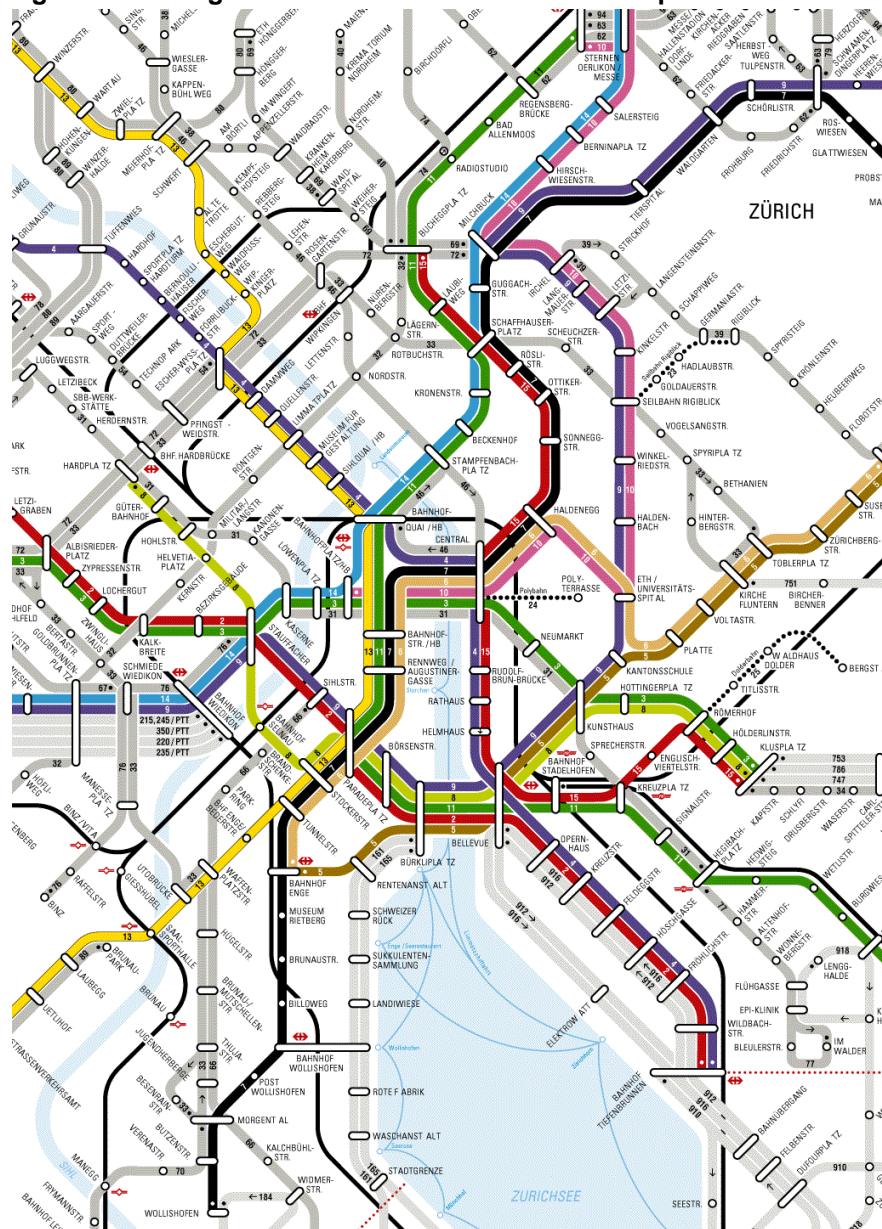
Indicator	Units of measure	Zürich	Bochum
Line density	Km of streets along which public transport operates, per km <sup>2</sup> of territory	3.0	1.7
Route density	Km of routes per km <sup>2</sup> of territory	4.9	2.5
Stopping points density	Number of stops per km <sup>2</sup>	5.6	3.8
Service density	Number of transport departures from stops on a weekday per km <sup>2</sup>	2440	460
The amount of service delivered in both directions:	Average number of departures per stop		
Rush hours		408	92
Off peak hours		294	85
Late evening		177	41

In addition, Zurich has its routes going not only towards the city centre and back as it also boasts link routes. The routes make up a network within which with the waiting time during transfers is little thanks to short intervals. When demand is weakening not allowing for short intervals, timed schedules are put in operation at intervals multiple of 60 minutes, which are repeated every hour and coordinated in hubs between train, tram and bus routes.

<sup>77</sup> HiTrans Best Practice Guide. 2. Public transport — planning the networks. Gustav Nielsen, et al. HiTrans, 2005.



Figure 3.37. Integrated network of all modes of transport in Zurich. Coloured are tram lines; black thin lines are railways, grey lines - buses, the red dotted line is the edge of the tariff zone.



To achieve high coordination, all routes operate on a strict schedule; the schedule requiring priority for public transport. These measures have been implemented in Zurich for more than 30 years.

The transportation speed in Zurich is not very high, but the decrease in speed, unlike in other European cities, is not caused by traffic congestions or waiting times at traffic lights. The main reason behind the transportation speed being moderate is the need to make frequent stops with more time spent by passengers getting in and out at stops than in any other system.

A comparative analysis of 43 public transport systems of the world's cities conducted by

UITP confirms that Zurich, along with Bern (Switzerland), delivers transport services of outstanding quality. Also, Zurich has a relatively high index of convenience in relation to private vehicle trips from the perspective of road network quality, transportation speed, parking availability in the city centre and private vehicle use costs.

It should also be noted that citizens in Zurich have voted twice against the construction of a metro line, since a cost comparison of the projected growth in taxes and the potential gain in transport service quality unequivocally proves that a metro in Zurich would be inefficient, given the agglomeration population of over 1.05 million citizens. It proved to be much more practical and prudent to focus on maintaining the high quality of tram, suburban railway and bus service as a single integrated network.

The main conclusions on the reasons behind the outstanding success of Zurich's public transport:

- A high-quality public transport system which rests on a system of tram lines and railways is able to challenge transportation by private vehicles and become the main mode of



transport in a city where citizens welcome public transport, even without imposing strong limitations on private vehicle use;

- The key principles behind the appeal of public transport are the network characteristics of the system. It is a fully integrated system (in terms of tariffs and schedule) with a high (6-10 minutes) traffic frequency on most of the routes and numerous convenient interchange hubs, which has been operating steadily for many years;
- Preservation and development of street transport (tram and bus) without an expensive metro system put in place is an important aspect of success where a substantial condition is to give priority in street traffic to the tram and the bus.

**Experience of Jönköping (Sweden) in route network modernisation.** In 1996, Jönköping, a city in Sweden (with a population of more than 80,000 people), completed the upgrading of its bus route network. The entire network is built around three diametrically routes, each crossing the city all the way through with the rest of bus routes acting as feeders for the three main diametrical routes.

The three main routes are designed as per the same principles according to which the tram lines are usually designed after “the image of a tram” with straight and fast routes, high speed transportation, punctuality throughout the entirety of the urban built-up area (Figure 3.38 top). This was achieved by implementing a number of necessary measures, namely, traffic management and traffic light cycles introduced with priority given to public transport (Figure 3.38 middle), dedicated lanes and road sections for public transport traffic only (Figure 3.38 bottom), optimised location of stopping points, informing passengers on the location of buses en route by electronic displays in real time.



**Figure 3.38. Integrated bus network with three main and diametrical routes (shown in red, yellow and green colours), priority PT transit across intersections, Dedicated roadway for public transport traffic only in Jönköping (Sweden)**

New, low-floor articulated buses equipped with four wide doors (two for embarkation, two for disembarkation) were put into service on the routes, an electronic integrated fare payment system featuring a very simple rate menu was introduced making bus trips fast and reliable. Fast and efficient transportation drew enough passengers to the main routes to warrant operating at intervals of 5-10 minutes almost throughout the entire day. Small intervals encourage passengers from the suburbs to make transfers from the local routes to the three main routes during their trips. Other routes (except for the main routes) operate at an interval of 30 minutes almost all day.

The main and local routes feed passengers to the station; a coordinated schedule for the first and last routes is introduced. The regional system of tariffs is a fully integrated one. The single railway and bus transport interchange hub (TIH) provides passengers with access to complete information on the network, waiting conditions and catering. The TIH project envisages a minimum walking distance from trains to buses, that is the bus landing platforms are located very close to train platforms.

The results of the retrofitting works were nothing if not impressive. The passenger flow grew by 15% in a five-year period, while prior to that it had been steadily decreasing by 1- 2% per year. Similar

cities in Sweden, which have not yet carried out such reforms still have the passenger flow decreasing by 1- 2% per year. The proportion of public transport in Jönköping rose from 19% to 22%. PT mobility increased to 143 trips per year per capita, which is one of the best results among similar cities. The share of expenses covered by ticket was 68% up from 32%.

**Copenhagen's experience in developing a main route network.** The Copenhagen Region is vigorously working to improve the speed, reliability and appeal of bus transportation. Measures taken to improve the transportation speed include road traffic management, in particular dedicated lanes, installation of barriers allowing buses only to enter certain sections of the road network intended for buses only, increase of interstop intervals by moving and closing down some PT stops, priority of passage at intersections, forward-direction passage for buses coming from right-turn lanes and street load management by traffic lights.

Another significant measure is to optimise the route network by setting up main lines. Six bus routes are designated as main city routes (A-buses) operating at intervals of 3-5 minutes throughout the day, which means that passengers can use the bus without having to consult the schedule first. There are also six suburban express routes (S-buses) designated complementing the network of commuter S-tog trains. The buses operate in full tariff and route integration with the network of S-tog suburban trains and metro, together making up the framework of the Copenhagen transport system.

A-buses (yellow with a red angle) and express S-buses (yellow with a blue angle) are marked as high-level service buses. The buses are covered with their distinctive colours with special symbols also present at the stops, making it easy to spot them in heavy urban traffic (Fig. 3.39, 3.40).

**Figure 3.39.** The network of main-line A-buses in Copenhagen (Denmark) (red-lined) and suburban express S-buses (blue-lined) complements the network of commuter S-tog trains (S-marked) and metro (M-marked), collectively forming the framework of the Copenhagen public transport with a full tariff integration.



minute interval during the day)

**Fig. 3.40 Copenhagen (Denmark).** Left: S-bus (suburban express), right: A bus (main-line city bus, 3-5-



**Experience of the city of Lemgo (Germany) in managing a route network in a small city.**

The German city of Lemgo (a population of more than 40,000) is one of the most successful small cities in managing bus traffic. City buses are all unified under a single corporate style that stands for durability and stability of bus traffic with no advertising allowed for these buses. Three diametrical routes pass through the city centre; the fourth route encompassing the industrial zone. Each of the diametrical routes delivers transport services in the area accessible for 8,000 residents on foot, departing on a timed schedule every 30 minutes throughout the day with a doubled frequency at peak hours. In the late evening, buses are replaced by taxis to match the level of demand (Figure 3.41-3.42).



**Figure 3.41-3.42. In the city of Lemgo (Germany) a unified style, unified information support and coordinated timed schedule have been developed for city buses<sup>78</sup>**



There is a transfer terminal between all four routes with one compact central platform in the centre of the city. Thanks to the timed schedule, all buses converge in the city centre at the same time which allows passengers to transfer within one minute with no time wasted waiting for buses to come.

A survey conducted in the city centre showed that the bus system has a significant impact on citizens choosing to come around more often to the city centre to do the shopping. Bus passengers visit the city centre more often and spend more money in shops than motorists.

**Cambridge (UK) — experience of barring private vehicles from entry to the historic centre.** Radical measures were necessary to tackle the issue of the historic centre being overwhelmed by vehicles. The implementation of this scheme required the support of the majority of the population which was achieved through numerous consultations with the public, involving citizens in the decision-making process as well as promoting the proposed decisions.

Barred entry into city centre for private vehicles and improved bus services resulted in a record-breaking demand for public transport with 27,000 passengers arriving at the centre by bus daily. The goal to drive up the public transport passenger flow by 20% within 4 years was achieved in 3 years with the flow having climbed by 30%.

The scheme is backed by local citizens, as the bus service functions in a reliable and convenient manner and the urban environment in the city centre has improved. Bollards (automatic cylinders which move out of the roadway surface to block passage) grant access to public and service transport and prevent other private vehicles from entering quite efficiently.

**City central area revitalization.** Several cities replaced car traffic in the city centers with tramway lines, in order to create safer, cleaner, better-for-life areas. Special attention is paid to old-style vehicles, which become tourist attractions and even more support livable cities (Figures 3.43-3.49).

<sup>78</sup> HiTrans Best Practice Guide. 2. Public transport — planning the networks. Gustav Nielsen, et al. HiTrans, 2005.



**Figure 3.43. Parla, Spain. In order to reach the high quality of life cities close their central areas for cars and provide the attractive pedestrian space and rail public transport.**



**Figure 3.44. Antalya, Turkey. The new line with old-style vehicles was built in the city centre to attract tourists and provide the tourist area transportation.**



**Figure 3.45. Istanbul, Turkey. Narrow historical streets can be adopted for every means of transportation – public transport, pedestrians and private cars.**





Figure 3.46. Istanbul, Turkey. Curved rail lines make pedestrian areas even more attractive.



Figure 3.47. Istanbul, Turkey. Historical areas with narrow streets are best served with tramway lines due to ability easily adopt. Old-style tramways are welcomed by the visitors.





Figure 3.48. Moscow, Russia. Tramway line serves pedestrian Baumanskaya street.



Figure 3.49. Toronto, Canada. Tramway lines are preserved in downtown as the most efficient means of transit, providing the cheapest, safest and most ecological transport.



**Edinburgh, Scotland: experience in assessing the socio-economic effectiveness of decisions taken.** The evaluation process of the Transport Initiative of Edinburgh and South East Scotland is an example of the British approach to developing urban transport policies, including public transport and congestion payments (fees for entry to congested road areas). The city describes the objectives, indicators of their evaluation and the data necessary to evaluate the project (Figure 3.50).



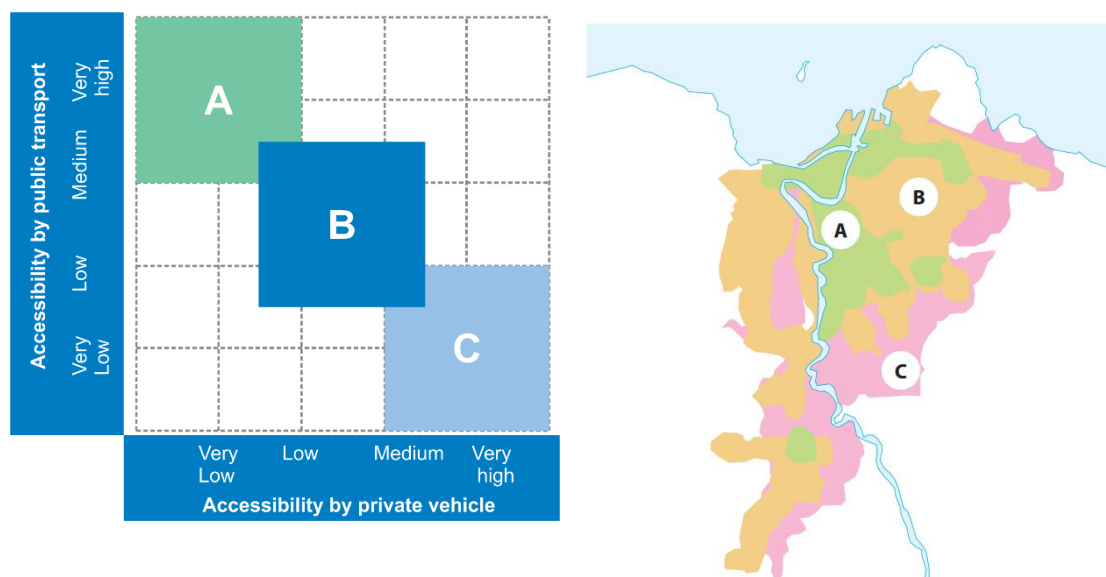
**Figure 3.50. An example of evaluating urban transport policy measures for decision-making in the city of Edinburgh (UK)<sup>79</sup>**

Objective	Measures	Data
Cost-effectiveness	Reduced travel time Transportation reliability Operating costs Capital expenditure Payments Taxes and budget efficiency	Transport modelling Transport modelling Analogue objects Analogue objects Transport modelling Financial and transport modelling
Local economy	Increase in employment level Economic impact	Economic model Economic model
Environment	Air quality Pedestrian environment Visual environment disturbance Reduction of green space Noise	Transport modelling Qualitative evaluation Qualitative evaluation As per the settings of the project Transport modelling
Safety	Prevention of road accidents Personal safety	Transport modelling Qualitative evaluation
Accessibility	Accessibility measures Remoteness	GIS/Transport modelling Transport scheme evaluation
Integration	User-friendliness Effect by slow modes of transport Integration with urban planning	Qualitative evaluation Mode of transport Transport modelling, qualitative assessment
Social integration	Effect by income groups Accessibility for low-income persons Revitalization of territories	GIS GIS/Transport modelling Building modelling/quality assessment
Health	Life expectancy	Qualitative evaluation
Risk management	Public and political approval Technological risks Financial risks Security risks	Consultations Expert opinion Financial model Qualitative evaluation
Financial matters	Revenue collection Capital expenditure structure “Unproductive” expenses (interest on loans, etc.)	Transport modelling Project schedule, cost structure Financial model

**Norway, the experience of linking land use and transport planning.** Norway has proposed a way of evaluating areas by their accessibility by different modes of public transport. That allows for choosing a specific area for certain types of activity (Figure 3.51). An example from Trondheim (Norway) is presented below (Figure 3.52). Concentrating jobs in Zone A will maximise the demand for public transport while reducing the demand for private vehicles.

<sup>79</sup> HiTrans Best Practice Guide. 2. Public transport — planning the networks. Gustav Nielsen, et al. HiTrans, 2005.

**Figure 3.51 -3.52 The methodology used to evaluate territorial accessibility by public and private transport with the aim to link land use and transport development in Norway (left). An example of evaluating territorial accessibility by public and private transport with the aim to link land use and transport development in Trondheim (Norway) (right)**



**Stockholm, the experience of modelling and developing a tram-line Project Feasibility Study.**



The tram line was built and went on to become a great success for the Stockholm region (Figure 3.53). This experience serves to illustrate the importance of devoting adequate attention to detail and setting aside sufficient time for transport models to be elaborated in a quality manner.

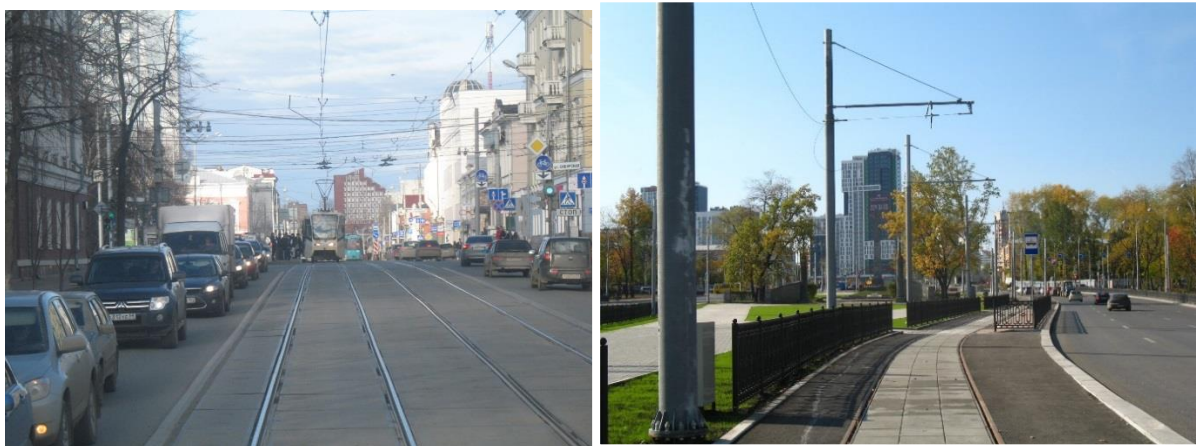
**Figure 3.53. In Stockholm (Sweden), the tram line was built despite the passenger flow shown to be three times lower by the repeated transport modelling study. Now the tram line is in high demand among passengers**

Sweden has carried out a study into the effectiveness of various public transport projects in the Nordic countries. In order to compare different projects, the unit costs per one attracted (additional) passenger were selected as the main criterion. While in no way universal, these indicators and the approach itself are very efficient in making policy decisions on urban transport given adequate awareness of the particularities of each project.

**Separation of tramway tracks from the road, providing platforms for seamless boarding.**

In a number of Russian cities and worldwide, tram tracks are separated from the carriageway by a curb stone in order to ensure reliable operation of tram transport. Tram platforms for embarkation and disembarkation are being improved to ensure convenient entry for passengers with reduced mobility, that is women with prams, passengers carrying luggage, elderly people and disabled passengers (Figures 3.54-3.61).

**Figure 3.54. Separation of tram tracks in Lenin Street in Perm (left) and construction of a new tram line in the centre of Yekaterinburg in 2016 (right).**



**Figure 3.55. Perm, Russia. Tramway stop outside of the city center is equipped with isle platforms, providing safe boarding to the tram even on the narrow street. Note the platform level on the external curved part of the track.**





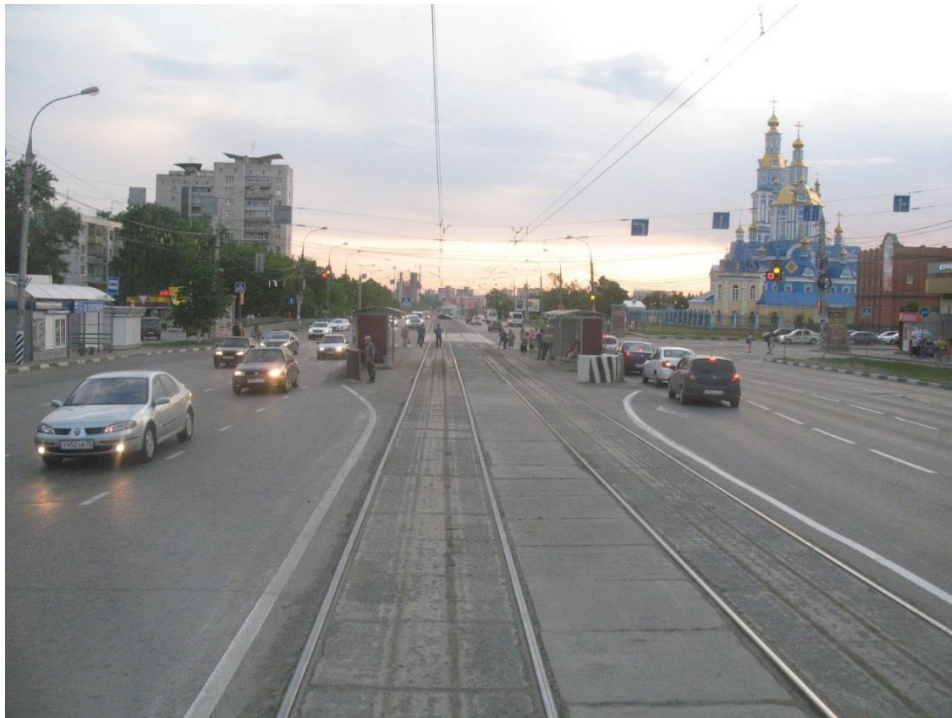
**Figure 3.56. Moscow, Russia. Tramway line is separated from car lanes with delineators.**



**Figure 3.57. Dusseldorf, Germany. Individual solution to separate only one way of tram track in a narrow street conditions.**



**Figure 3.58. Ulyanovsk, Russia. The road lines are reduced to provide the space for isle platforms. This solution provides not only the safe boarding, but also allows the cars to move without stopping on tramway boarding.**



**Figure 3.59. Geneva, Switzerland. The road pavement is risen at stop area to the platform level, providing not only convenient boarding for the passengers, but also the safety on boarding and priority for tram movement. This type of the tram platform is called “Wien platform”.**





**Figure 3.60. Moscow, Russia. Separation of tramway line and bike lane from the car traffic, widening of the sidewalks in Moscow center in 2017 demonstrate the new priorities of Moscow government in transport policy.**



**Figure 3.61. Paris, France. Green track is a technology, allowing to expand green space in the cities.**





**Priority for public transport.** In order to provide better travel speeds, cities organize bus lanes, or reduce car traffic on the streets by means of traffic management.

**Figure 3.62. Moscow, Russia. Bus lanes, implemented in 2018, provided in both directions on a one-way street so as to provide two-way passenger service.**



**Figure 3.63. Moscow, Russia. Implementation of public transport priority at the intersection: only public transport allowed to cross the street in direct way. The same method effectively realised in Toronto, Canada.**



**Elimination of back-up routes and creation of a main route network in Russia.** The route network Magistral was designed in 2013 and implemented in 2016 for the central part of Moscow where public transport traffic is allocated a dedicated lane opposite to one-way vehicle traffic around the Kremlin. This helped restore two-way public transport connections lost when the one-way ring traffic pattern around the Kremlin was introduced for private vehicles in the 1990s.

The Magistral network has made the routes in downtown Moscow simple and clear to understand and the traffic frequency has become high (Figure 3.64). The routes are divided into categories: main routes (high-frequency traffic throughout the day to connect with districts within the city), district routes (to ensure transportation of citizen from the districts to the metro and the main network), social routes (which connect to all places of social significance within a district without transfers operating on a timed interval of 30 minutes).



Figure 3.64 Moscow (Russia). The scheme of the Magistral route network in the Moscow centre is simple, understandable and convenient for passengers



**How Dutch railway stations encourage multimodality<sup>80</sup>.** The Dutch experience shows that providing accessible and numerous bicycle parking facilities at public transport hubs, such as railway stations, is crucial in fostering multimodality. Combining different transport modes can make journeys faster, more convenient, more reliable and more predictable. Plentiful and secure bicycle parking facilities at public transport hubs can increase the overall efficiency of the transport network. As it enables longer distances to be travelled in less time, cycling dramatically increases the catchment area of public transport, allowing more people to travel in a sustainable way.

The Dutch approach to cycling infrastructure investment is an excellent example of strong national support for multimodal transport, in spite of the implementation of the infrastructure being a local issue. In the Netherlands, more than 40 % of train passengers travel to railway stations by bicycle, whereas only 11 % of bus passengers travel to bus stops by bicycle.

<sup>80</sup> <http://www.eltis.org/discover/case-studies/how-dutch-railway-stations-encourage-multimodality>, Francesco Ripa, Brussels Region, Belgium, Polis, Polis Network, 2019.



Dealing with the increasing demand for parking places in public transport hubs is a challenge for local authorities. Dutch municipalities and provinces that are responsible for constructing bicycle tracks and encouraging the use of bicycles have made headlines for building some of the world's largest bicycle parking facilities. The city of Utrecht has recently opened a three-storey underground bicycle parking facility at its central station (Utrecht Centraal) with room for 12 500 bicycles.

The Action Plan for Bicycle Parking at Stations partially succeeded in reducing the anticipated deficit in bicycle parking spaces, especially at smaller stations. The subsequent actions built extensively on the results of the Action Plan and strengthened the dialogue between all of the stakeholders involved.

Data reveals that cycling in combination with public transport is on the rise. Some 40 % of the 1.2 million daily rail passengers ride their bicycles to train stations. The initiatives presented above have all contributed to helping to meet the increasing demand for more and better parking facilities at stations, thereby encouraging multimodal transport behaviour.

Municipalities and provinces have been encouraged to invest significantly in bicycle parking, resulting in a total of 96 000 parking spaces being added since 2012, when the Action Plan for Bicycle Parking at Stations was launched. The overall deficit of parking spaces has been reduced, but not completely, although more people are now able to cycle to public transport hubs and continue their trip by train or bus. Moreover, the improvement of cycling infrastructure has also led to significant environmental, social and economic gains.

The model of multi-stakeholder cooperation is the main strength of the Dutch example. Although the levels of ambition and investment are due to the Netherlands being the country with the highest number of bicycle trips per year, the model of multi-stakeholder cooperation can be a source of inspiration for other countries seeking to improve the efficiency of cycling infrastructure with a special focus on bicycle parking facilities. The Dutch experience offers a strong case for greater cooperation between municipalities, service providers, civil society and research institutions to make multimodality a reality in cities.

**City of Dundee, United Kingdom. Transport Systems & Services: the measures taken<sup>81</sup>.** Dundee scored maximum points for PT coverage, which is reflective of the extensive bus network operation within the city boundaries. For other bus related indicators (speed, affordability and ease of use) they scored relatively lower, particularly in relation to cost, although this is likely to be due to the fact that fares are typically higher in the UK by EU standards and wages are typically lower in Dundee from the UK average. The usability of Dundee buses was let down due to the lack of integrated fares (two companies operate buses within the city) and lack of fare information and ticketing purchasing options. They also scored highly on 'Accessibility to services' and 'Planning of new areas' (both 80%). This was due to Dundee's efforts on ecomobile oriented and accessible land use planning. They also scored highly on information systems due to the high levels invested by the city (RTPI at bus stops) as well as the quality of information provided by the local bus operators. Similarly, for both accessibility for people with reduced mobility and walking conditions, Dundee scored highly, both 80%. This again is due to the high levels of investment made by the city in improving walking areas and public transport facilities, the latter in conjunction with the local public transport operators. They did score relatively less on mobility management services, parking policy, car free/low speed zones and cycling conditions, all of which pulled down the overall score for this indicator grouping, although, highlighted the need for improvement in these areas. The lowest score related to green vehicles, although, this was in part due to the city

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<sup>81</sup> <https://ecomobility.org/ecomobility-shift/>, City of Dundee, United Kingdom, EcoMobility SHIFT Case Study. EcoMobility SHIFT is a total quality management scheme for cities, with an assessment and an external audit. During the assessment stage, 13 criteria are assessed using 28 indicators. A municipal stakeholder group evaluates the effectiveness of a city's sustainable transport policies and actions in terms of environment, accessibility, safety and equity. It is the first scheme of its kind to include all of the following three elements: the policy environment (Enablers), the actual measures (Transport Systems & Services) and the effects of these on the transport system (Results & Impacts).

been unable to find evidence related to public ownership of low emission vehicles, as such data is not currently available.

**City of Burgas, Bulgaria. Transport Systems & Services: the measures taken**<sup>82</sup>. Burgas has a lot of work to do to reduce the need of travel. Planning and construction of the central city areas in the last few years increase the options of non-car traveling, but still 58% of the trips of people living in Burgas are made by car. There is an increasing share of public transport by 5%, compared to the previous year, but the car still remains the dominant mode of transport, with the bicycle transport still taking an insignificant share. The City Council has approved some strategies for sustainable urban development, currently implemented by the municipal administration. There are some restrictive measures and some supporting measures to encourage citizens to leave the private cars. Burgas Municipality has introduced paid parking – Blue Zone in the central areas of the city. This restricts the access of cars to the main administrative and market area, turning it immediately into pedestrian zone. The local PT company is owned by the Municipality, has its own budget and receives donation from the state authorities. With the current implementation of Burgas integrated public transport project the Municipality is introducing an improved, optimized, more attractive and accessible public transport scheme and service to the local community, guests and tourists of the city. The project will introduce a Bus rapid transit lane that will provide a priority to the public transport and will make it faster, attractive, and affordable, thus increasing its popularity and preference among the local community. A special service available to disadvantaged people is “Ring and Ride”. Burgas has made serious social costs of transport services “Carriage of persons with reduced mobility” and “Transportation of children with disabilities.”

### 3.3 Financing public transport

*Public Transport projects are often constrained by high upfront capital costs, low returns and long development and payback periods. In addition, direct user fares are often set too low to cover operational costs, due to social affordability concerns. Several financial tools and risk-sharing mechanisms are available to improve the relative risk-return profile of sustainable transport infrastructure projects:*

- Public-private partnerships (PPPs) are procurement methods that allow for private sector participation and risk sharing. PPP projects must offer sufficient “value for money” compared to traditional public procurement. PPPs are particularly suited for BRTs, rail links, and shared-use vehicle systems.
- Loans, grants and loan guarantees are traditional financial tools frequently used to leverage private investment in large-scale transport projects (rail or metro) that otherwise would be fully owned and operated by public stakeholders.
- Green bonds have the potential to attract institutional investors such as pension funds and insurance companies by tapping into the debt capital markets, which are currently underexploited for green infrastructure investment.
- Short-run subsidies can be used to provide transitional support to sustainable transport options and technologies. They notably can be used to foster innovation, ramp-up production, offset upfront capital costs, and compensate for network infrastructure bias toward fossilfuel-based road transport. Examples include support to charging infrastructure for electric vehicles (EVs) and plug-in hybrid vehicles (PHEVs).

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<sup>82</sup> <https://ecomobility.org/ecomobility-shift/>, City of Burgas, Bulgaria, EcoMobility SHIFT Case Study.

**Figure 3.65. St Petersburg, Russia. The public-private partnership allows to rebuild tramway line in Krasnogvardeisky district according to the light rail standards**





**Figure 3.66. Usolye-Sibirskoye, Russia. In order to provide interconnectivity between intercity rail and urban transport systems, the tram line was prolonged to the railway station. This project demonstrated efficiency even for the relatively small town.**



### 3.3.1. Different models

The key issue in choosing between the regulation of public transport and the free transport market has remained controversial for decades. To date, experience the development of urban transport systems around the world has shown that the most effective management model is that of coordinated development of urban transport as a single system (i.e. centralised planning of routes and their parameters for the whole city, forbidding providers from designating routes independently, etc.), while competition is maintained through bids for the right to operate scheduled routes in accordance with the established parameters.

Different approaches to the objectives and principles of public transport networks generate different approaches to urban transport planning (Figure 3.67).

**Figure 3.67. An analysis of differences in terms of the transport policy between the UK and France<sup>83</sup>**

	<b>United-Kingdom</b>	<b>France</b>
	<b>Objective: improve the efficiency of transport systems by reducing road congestion</b>	<b>Objective: develop liveable cities by replacing private vehicles with alternative modes of transport</b>
Political context	Less emphasis on curbing private vehicle use. Since bus transportation outside London is deregulated, most urban transport is not part of the planning objectives for the authorities.	French legislation on urban transport demands reduced private vehicle use. Light rail transport is seen as one of the key tools to achieve this goal.

<sup>83</sup>HiTrans Best Practice Guide. 2. Public transport — planning the networks. Gustav Nielsen, et al. HiTrans, 2005.

	Local government initiatives are limited with modest budget funds. Dependence on the central government for most of public transport financing.	Efficient city administrations with influential mayors who are leaders, sufficient local sources for financing public transport.
	Light rail transport is deemed as only one of the transport solutions, without taking into account its impact on urban planning and building development	The revival of cities through high-quality public transport management is a source of political status and pride for cities
	The government's responsibility is limited to public transport infrastructure and bids for non-commercial (social) routes. Too weak a position to achieve integration of rail transport and competing bus operators.	Significant involvement of the government in all the aspects of public transport, namely in infrastructure, bids for transportation, ownership of operators.
	Lack of organisational unity between the central government (infrastructure financing) and regional transport administrations responsible for transport planning and operation.	Separation of organisational objectives between urban and regional public transport. Integration of regional and city tariffs (among several modes of transport) is rare.
Characteristics of LRT projects	Provides regional transportation along commuter "suburb - agglomeration centre" routes.	Improves primarily urban transportation in the agglomeration centre with less focus on the suburbs.
	There is no relation between LRT projects and the private vehicle use reduction policy	LRT projects are coordinated with measures to reduce vehicle use
	In many cases, the use of the existing railway (currently unutilised) infrastructure and its corridors for laying out routes for LRT	Generally, a completely new LRT infrastructure: measures to revitalise streets along the LRT corridor cost up to 50% of the overall LRT construction expenses
	Minimising budget financing and risks by involving private capital	Completely budget financing
	A long period from initial works to commissioning	Typically, just a few years from the proposal phase to commissioning works
Common features	LRT is considered as the best (even the only) opportunity to ensure that sufficient priority is given to public transport in the city streets in both countries.	
Cities for analysis	Manchester, Sheffield, Birmingham, Croydon	Lyon, Marseille, Montpellier

The authors' analysis has revealed significant differences in approaches to the development of urban transport systems in Great Britain and France; the differences being caused by different social and political backgrounds of the two countries.

The "en route" competition allows providers to compete with each other for passengers, with or without restrictions, which best corresponds to the "free competition" model; in practice, the complete absence of restrictions in developed countries does not occur with at least requirements established for transport safety.

Regular bus transportation is deregulated in the UK (except in London). Operators enter the transport market freely through a registration process where a company should not obtain the

right to work on the route as it is enough to have a transportation license and meet the applicable safety requirements. Immediately following the deregulation, operating costs and subsidies decreased significantly with the amount of traffic slumping at the same time.

The disintegration of rail and bus transport systems in the Tyne-and-Wear county which had built an LRT system prior to the deregulation coordinated with bus transport by feeder routes and an integrated fare payment system was an example laying bare the disadvantages of the “on the route” competition. Following the deregulation, this coordination was eliminated: the LRT which earlier had drawn passengers in the whole region by means of feeder bus routes had its coverage area limited to stations located within walking distance for pedestrians. In addition, bus operators set lower rates by duplicating LRT lines, which further brought down the LRT passenger flow, decreased the efficiency of rail transport to the point where its operation had to be reduced. On the other hand, with the extension of the LRT line to Sunderland, the passenger flow of bus operators will be decreased by 12-15%, which in turn will destabilise local bus operators, while the performance of the LRT will also remain insufficient. Such competition is detrimental to all of the operators in the region and the transport system as a whole.

To integrate bus transport with other modes of transport, separate planning is no longer provided for bus transport (bus service is viewed in conjunction with other modes of transportation, which is deemed to be more effective). LTP is developed through consultations with interested organisations, operators, and most importantly, members of the general public. It is necessary for LTP to:

- account for the environmental situation and policies, be in harmony with environmental conservation efforts;
- take measures to ensure equal access to transport space for persons with disabilities and reduced mobility;
- plan for development and use of parking space;
- provide charging stations for electric vehicles.
- LTP's contain a description of the strategic transport policy and measures for its implementation.
- The implementation of local transport plans is accompanied by local district agreements that stakeholders are invited to become a party to with the involvement of the public.

**Factors of public transport success.** The main criterion of successful public transport development, based on the purpose of public transport as a tool to reduce externalities (adverse consequences of the operation of the transport system), according to experts, is often the share of passenger demand that has been shifted to public transport (owing to its appeal) which leads to less externalities in the transport system.

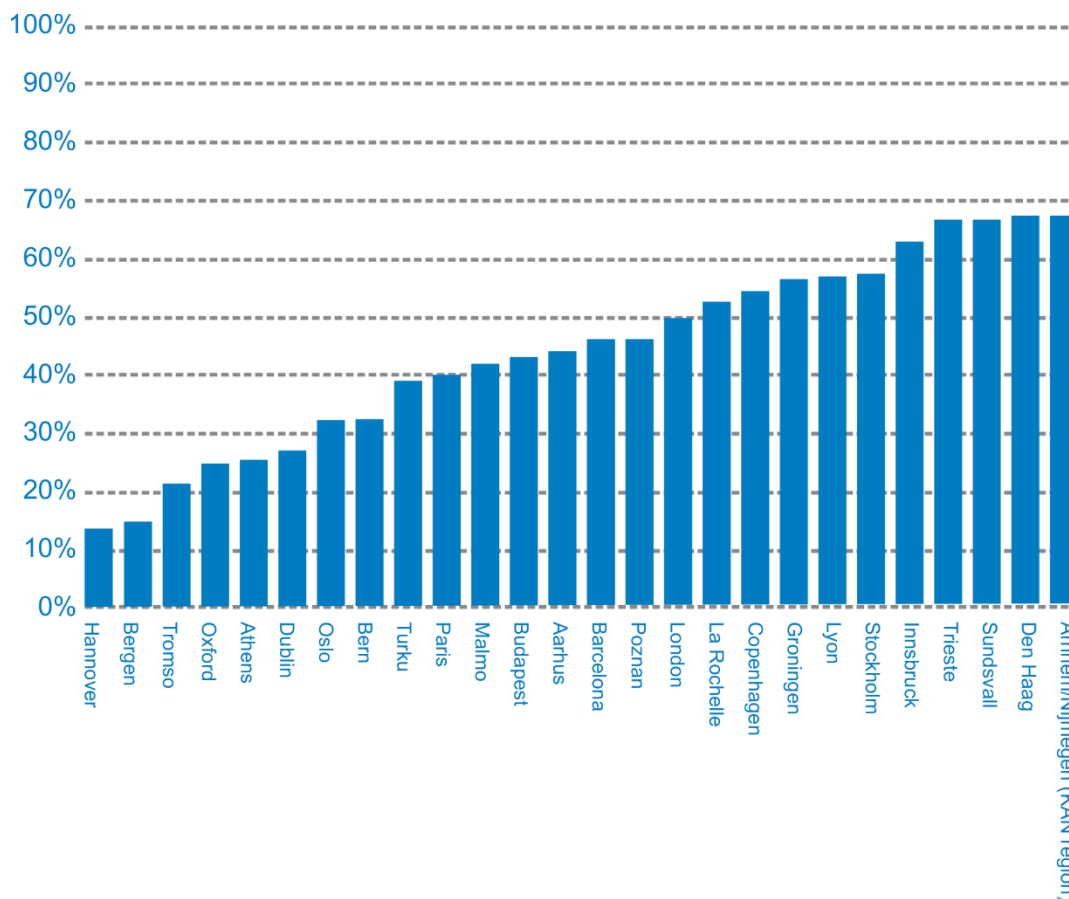
Among experts of 20 cities (including: Madrid, Barcelona, Berlin, Copenhagen, Helsinki, London, Munich, Zurich and Vancouver), a survey was conducted in order to identify the factors that determine the successful transport system: the most instrumental factors were assigned 3 points, the moderately instrumental ones had 2 points, and insignificant ones had 1 point, while negative factors were given minus 2 points.

As is evidenced by the survey, the most important political factors are coordinated planning and control over the transport system at the level of the whole region (agglomeration) while the most critical factor of the transport policy is an integrated tariff (ticket) system, as well as adequate financing (investment or subsidies).



The level of subsidies for public transport varies widely across cities around the world. Data on the level of subsidies are shown below<sup>84</sup>.

Figure 3.68. Level of subsidies for public transport in the world's cities (share of costs covered by subsidies)



Large PT infrastructure development projects **are mainly financed** by central governments (by way of loans and grants), whereas local projects are funded via local budgets and taxes funds. In some regions (e.g. Stockholm), the authorities have the power to raise taxes to finance infrastructure development. Rolling stock is retrofitted through leasing schemes.

**Contracts with providers and quality control.** In practice, there are two fundamentally different types of contracts for route transportation: the gross cost contract and the net cost contract. With the gross cost contract, all revenues from fares are collected by the customer (the city or region), whereas the net cost contract implies that all revenues are collected by the fleet operator (carrier) on its own. Under the gross cost contract, a subsidy paid by the customer may actually be reduced if the customer sees a high collection of revenue. From the standpoint of authorities, the gross cost contract offers significant benefits, especially for routes with latent demand, which, with high quality transportation service in place, can allow for a significant revenue growth and a reduction in subsidies.

A possible disadvantage of the gross cost contract in some cases is the low involvement of the operator in quality improvement, especially in countries with a high share of personal transport, where transportation quality is a significant factor in increasing the share of public transport. In order to prompt an operator to improve quality, payments under the contract in Norway are tied to a growth in the passenger flow (with a bonus paid for achieving a certain

<sup>84</sup> HiTrans Best Practice Guide. 2. Public transport — planning the networks. Gustav Nielsen, et al. HiTrans, 2005.

level of growth). This is the case in New Zealand. It should be noted that with integrated planning, such decisive factors in passenger flow growth as the schedule, frequency, route roads are already defined by the client (city) and do not depend on the operator; however, the dependence of the operator's remuneration on the number of transported passengers stimulates the operator to break the schedule, leading to overtaking other vehicles on the same route and "long waiting time" at stops so that the cabin can fill up with more passengers. These measures do not result in an improvement, but instead translate into a deterioration of transportation quality under net cost contract. In fact, net cost contracts mean reduction of control over public transport operators and rise of "race-over-the-passenger" risks, leading to decrease of service quality.

Tendering proceedings in Oslo (Norway) include not only bonuses, but also penalties for breach of contractual terms. The contract defines the level of service. The amount of the contract can be increased or reduced by 3% per year depending on the achieved quality of service. The transportation customer is constantly monitoring the quality level with more than 1,000 inspections carried out per month. Along with inspections, surveys among passengers are conducted.

Five Oslo transport operators publish their service quality performance indicators on a monthly basis. These indicators have a bearing on monthly payments under the concluded contracts. The monitoring results are reported monthly to the operators' staff, so the culture of quality improvement extends throughout the entire company.

The operator pays a fine for each detected violation. For example, in 2004, a fine of 610 Euro was imposed for each of the following violations:

- departure from a stop before the time set in the schedule;
- violations in selling tickets to passengers;
- violations in the transportation vehicle type or its colour design;
- malfunction of exhaust filters.

A fine of 360 Euros is imposed for the following violations:

- No announcement of the next stop;
- Lack of information on the tariffs, schedules, quality guarantees for the passenger;
- The driver does not wear the prescribed uniform.
- The central government can have a significant impact on urban transport management through creating an appropriate regulatory environment and legislation.

Gross cost contract means the full control and responsibility of the customer (city) on the public transport quality of service. Passengers pay their fare to the city; the city organizes the public transport according to the quality standard, approved and monitored by the city. Public transport operators paid according to the quality they get by the contract – so they are responsible to the city and do their job as a musician in an orchestra, lead by the single director – the city.

Precise responsibility of a city for the service quality as a whole system, provided by the gross cost contract – leads to the most efficient solutions on public transport, financial sustainability of the transport system, better quality for less fares, closer reach of the public transport goals – reduction of externalities and social equality.



## **Chapter 4.**

# **Promoting active mobility for healthier urban living**



## Chapter 4. Promoting active mobility for healthier urban living



The 1,5° report published in October 2018 by the UN found that air pollution could save Europe up to \$775 billion by 2025, by saving on health costs and the economic damage of premature deaths, but also by increasing tourism and real estate values in places currently devalued due to dirty air.

The average person in Europe loses two years of their life due to air pollution. The report also estimates about 800,000 people die prematurely in Europe per year due to air pollution, or roughly 17% of the 5 million deaths in Europe annually.<sup>85</sup>

**Illustration:** electric vehicle charging point in rural and touristic mountain area in Austria. Source: Renaissance Urbaine

### 4.1 A synthetic review of the links between urban transport and health

#### 4.1.1 Time spent in transport and factors influencing consumer's choices: speed, reliability, service chain

##### Speed

In the urban passenger transport system, the key participant is the passenger, whose activity is determined by a variety of strategies and alternatives (different ways and routes that can be chosen) as well as the target function (minimization of the losses associated with movement).

With higher demand for efficient urban mobility, urban dwellers tend to choose between urban public transport and private cars; that choice of passengers being determined by the money and time spent on the trip and the ease of movement.

The probabilistic nature of the duration of the trip (unreliability of the trip) is to some extent intrinsic in all modes of transport, but it is of the utmost significance in relation to urban passenger transport.

Improved reliability of public transport connections is often achieved by tighter control over timetables, effective traffic and operational management, providing online information to

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<sup>85</sup> Source: WEF, 2019

passengers at stations and by means of apps in relation to public transport expected time of arrival (departure), route number and actual time of arrival of the next vehicle, automated monitoring and control of the operations of the transport system through integrating terminals, stations, transport companies and vehicles within a single information space.<sup>86</sup>

Reduced travel time is achieved by transport planning and demand management techniques. It should be noted that the target is not to reduce the time, but to increase the correspondence speed within the transport system (taking into account arrival at the place of embarkation, waiting time, trip, transfers). Citizens determine for themselves the time that they are willing to spend on transport; with improved transport opportunities, many prefer not to reduce the time in travel, but to enlarge the radius in which to find jobs and for other visiting purposes which is made possible by expanding the area achievable within an acceptable travel time (up to 1.5-2 hours). The objective target, determined exclusively by the actions of the planner (regardless of the choice of citizens) is not the time which citizens spend on travel, but the speed of transport correspondence ensured by the transport system.

An increase in the transport correspondence speed is achieved by solving the following transport planning tasks:

1. Improving route traffic conditions, including through the physical allocation of necessary lanes and traffic routes;
2. Optimising distances between stops;
3. Achieving reduced waiting time, including at interchange hubs, through coordination of traffic schedules.
4. Ensuring reduced walking distance at interchange hubs;
5. Introducing improvements into road traffic regulation, including by allowing priority passage for passenger transport vehicles at intersections;
6. Reduced on-foot door-to-vehicle distances.

Shorter distances at interchange stations are ensured through careful planning of interchange junctions aimed at reducing each extra metre of walking distance, replacing stairs with mechanized ascending and descending means.

Reduced door-to-vehicle walking distance is achieved by the introduction of transport service standards that limit the walking distance from buildings to stations and (if applicable) parking lots.

Mainly with public transport, increased speed can be achieved effectively thanks to dedicated lanes with priority passage. As will be shown below, increased speed of private vehicles generally leads to a rise in traffic accidents.

### **Reliability**

Reliable transportation is ensured by balancing capacity and the number of crews passing per unit of time (demand). With private vehicles, including cycling modes of transport, reliability (i.e. the balance of demand and supply capacity) can be achieved chiefly by demand management methods — price demand management (paid parking, paid travel through congested road areas) with a quality alternative ensured represented by public transport.

Reliability is best achieved for public transport, where the number of crews (demand) is determined by the scheduled and can be calculated accurately from the capacity of the infrastructure. Under gross contracts (the carrier is paid by the city for on-schedule mileage regardless of the number of passengers carried with penalties for violation of the schedule), it is in the interest of the carrier to adhere to the schedule (supervised by the navigational

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<sup>86</sup> In Moscow, transportation contracts include a zero tolerance policy for "ahead-of-schedule" practices (through departure before the scheduled time) with a permissible delay of 2 minutes maximum. In the Republic of Belarus, regular-traffic urban and suburban passenger transportation vehicles are allowed to arrive at a station not later than 5 minutes relative to the time on the schedule; long-distance road passenger transportation vehicles - not later than 10 minutes relative to the time on the schedule Based on the answers given by the Republic of Belarus to the UNECE questionnaire.

transport marks); no “chasing” passengers and higher ticket revenues. In this case, the planner calculates the maximum number of public transport crews that the system can handle without delay, and plans the route network in such a way so as to have the number of crews per hour at every section corresponding to the capacity of stations and crossroads.

Higher capacity of public transport infrastructure is achieved through:

- separation of tram tracks and providing dedicated lanes for road transport to exclude the influence of traffic factors and road accidents;
- creation of priority passage systems at crossroads (adaptive traffic light cycles) to mitigate the factor of a transport vehicle arriving at the wrong phase of the traffic light cycle by accident;
- providing a convenient environment for passenger embarkation and disembarkation (construction of elevated platforms up to 30 cm, a higher number of doors) to reduce the likelihood of delays during embarkation;
- ensuring that the activities of carriers are financially sound to provide for timely repairs and to avoid breakdowns of vehicles and tracks.

Estimates show that the free time of a working person is approximately 7 hours a day with about 8 hours a day accounting for work, 9 hours spent on sleep and personal needs. If a person spends 1.5 hours a day on trips on a daily basis, then transportation “strips” him or her of 20% of free time. With a growing urban population, the daily time in travel rises reaching 2 hours or more in large cities.

### **The time-money-service chain**

The buffer time represents the additional (absolute and specific) time expenditures on the trip due to transport connections lacking in reliability. Buffer time is estimated as time expenditures required to achieve the goal of the travel with a given reliability, such as 90%. The time buffer can be employed by using the cost of one passenger hour, vehicle-hour, etc., to estimate the additional economic costs to be borne by the user (driver or passenger) as additional time expenditures stemming from the transport system functioning unreliably.<sup>87</sup>

The time spent by people on transport movements is usually characterised as spent uselessly and irrationally, as opposed to the time expenditures on work, rest, education, communication, etc. The movement involved in the process is in itself not necessary, except when the trip is being taken so as to derive pleasure from the movement itself.

Unreliability of a trip is quantified from the distribution of probabilities of travel time along the route under examination depending on the length of the route and the traffic conditions. The buffer time set aside also depends on how significant the purpose behind the trip is whether it is “a meeting convened by the Minister” or a person running late for a meeting.

For a passenger choosing between travel options, it is not only the “time - money” chain that is important, but often also the “time - money - service” chain. The desire of passengers to pay for reduced travel time during which they experience comfort or discomfort due to various factors varies considerably. In practice, the list of such factors covers many conditions: stressful driving in heavy traffic, waiting at stopping points, the effects of weather, crowds, uncomfortable seats, lack of personal safety, etc. However, it is quite difficult to assign comparable values to all of these conditions and to measure the strength and duration of their effects.

Of interest is the fact that when choosing the desired transport mode, passengers often are not guided by the real physical time spent, but instead proceed from their psychological

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<sup>87</sup> In Moscow, Prague and a number of other cities, buffer time is taken into account at public transport final stops in order to send the wagon en route on time even following late arrivals to the final destination. In accordance with international practice, the buffer time should be approximately 10% of the estimated time of a turnaround trip. In Moscow, the buffer time is defined as the difference between the times of 90% availability (to ensure timely dispatch in 90% of cases) and 40% availability (to increase the speed of correspondence by route).



assessment the duration of the time. The time spent in travel for the most part represents overhead time in an individual's life, hence the interest in minimizing the time spent en route.

It is generally accepted that the value of travel time savings (VTTS) for business travel is equal to the hourly cost of gross employment (*the income of an employee excluding costs but including non - cash payments and and payroll taxes*). As different countries have different tax structures, labour markets, information resources and analysts' perceptions of the social groups studied, the definition of hourly income differs as well.

The cost of the time in travel saved depends on the particular passenger, circumstances and conditions of the trip and possible travel options. There can be no certainty that these factors will be stable. However, a large proportion of individual trips, such as trips to and from work, share similar purposes with their daily or weekly schedule repeated. By focusing on comparing several modes of transport and route options (for instance, tolled motorways as compared to parallel free highways), researchers can obtain an approximate explanation of the transport-related decisions of passengers with a controlled number of variables.

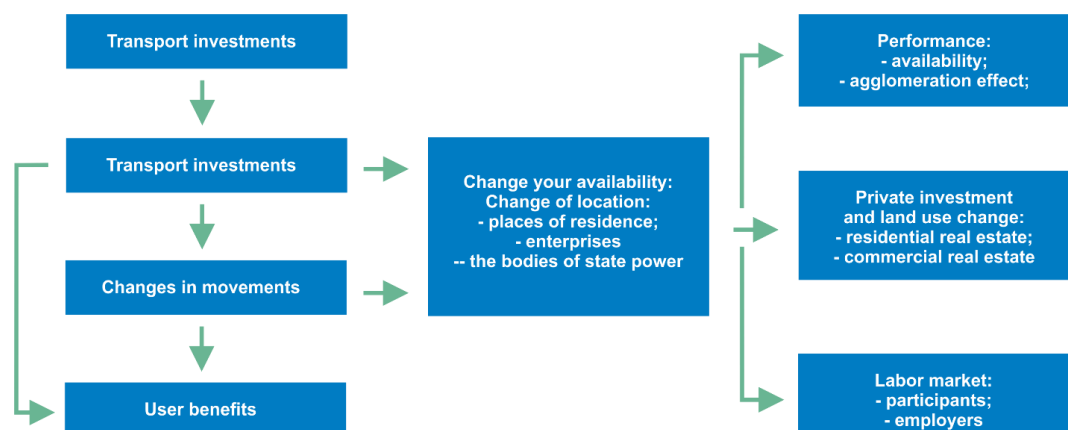
The value of reduced travel time of a passenger expresses three aspects.

Firstly, the time saved on the trip can be used for productive work thereby yielding monetary benefits either to transport users themselves or to their employers.

Secondly, this time can be used for rest or other pleasant or necessary activities not related to work.

Thirdly, the travel conditions throughout the trip or part thereof may be uncomfortable and cause stress, fatigue and discomfort in passengers, so reduced travel time under such conditions may prove to be more valuable than saving time under more comfortable travel conditions. These aspects define the differences in VTTS valuations. However, such valuations should factor in the possibility of using travel time for remote work (mostly given the advancement of modern technologies), for physical exercise (cycling), etc.

**Figure. A diagram that shows the relationship between direct passenger benefits, improvements in road traffic conditions and wider economic impacts, Venables (2015)**



#### 4.1.2 Pollution – including noise- and health

Motorised transport is the largest consumer of motor fuels, the combustion of which by internal combustion engines results in emissions of climate gases and, most importantly, CO<sub>2</sub> in addition to emissions of pollutants. The volume and composition of pollutant emissions discharged by motor vehicles depend not only on the environmental performance of rolling stock but also on the quality of the motor fuels used (most importantly, sulphur content), as well as the technical condition of vehicles in operation.

**Table. Specific emissions of different environmental classes of petrol-fuelled vehicles, g/km.**

STANDARD	CO	HC	NMHC	NOx	HC+NOx	PM
Euro-1 (1992)	2,72 (3,16)	-	-	-	0,97 (1,13)	-
Euro-2 (1995)	2,2	-	-	-	0,50	-
Euro-3 (1999)	2,3	0,2	-	0,15	-	-
Euro-4 (2005)	1,0	0,1	-	0,08	-	-
Euro-5 (2009)	1,0	0,1	0,068	0,06	-	0,005
Euro-6 (2015)	1,0	0,1	0,068	0,06	-	0,005

**Table. Specific emissions of different environmental classes of diesel-fuelled vehicles, g/km.**

STANDARD	CO	HC	NMHC	NOx	HC+NOx	PM
Euro-1 (1992)	2,72 (3,16)	-	-	-	0,97 (1,13)	0,14 (0,18)
Euro-2 (1995)	1,0	-	-	-	0,7	0,08
Euro-3 (1999)	0,64	-	-	0,50	0,56	0,05
Euro-4 (2005)	0,50	-	-	0,25	0,30	0,025
Euro-5 (2009)	0,50	-	-	0,18	0,23	0,005
Euro-6 (2015)	0,50	-	-	0,08	0,17	0,005

One passenger car absorbs an average of more than 4 tonnes of atmosphere oxygen each year releasing approximately 800 kg of carbon, 40 kg of nitrogen oxides and almost 200 kg of various hydrocarbons<sup>88</sup>. The transport pollutants emitted cause both local exposures (CO, hydrocarbons) and local and more global (regional, interregional) effects (NOx, SOx, PM).

#### **Focus. An assessment of air pollution impact on health**

It is important to point out that each of the transport air pollutants is specific in its own way in terms of its effect on human health. Air pollution by carbon monoxide (CO) results in anemia and cardiovascular diseases, headaches, a feeling of weakness and impaired productivity. Sulphur dioxide (SO<sub>2</sub>), combined with suspended particulate matter and moisture causes lung disease. Nitrogen oxide (NO) causes irritation of the upper respiratory tract as well as contributing to the development of anemia and heart disease. Lead causes a long-term adverse impact on human health resulting in hematopoiesis derangement and damage to the liver, kidneys, immune system. Aldehydes can boost the body's susceptibility to viral diseases, irritate the lungs, cause bronchitis and pneumonia. Studies indicate that particulate matter (PM) emissions from diesel engines are particularly dangerous. "Particulate matter" is a complex mix of different solid and liquid particles different in size. The most hazardous to health are ultrafine carbon particles of less than 2.5 microns which penetrate deep into the human lungs with its carrying extensive surface acting as a carrier of adsorbed organic carcinogen substances.

Atmospheric PM<sub>2.5</sub> pollution translates into an increase in the number of heart attacks, strokes, chronic bronchitis, asthma attacks and higher infant mortality.

Solid carbon particulates that are part of the PM are called "black carbon" (BC). Black carbon emissions from diesel-fuelled vehicles, along with severe health effects, produce an impact on the climate as they produce a significant light-absorbing effect.

<sup>88</sup> Molodyye uchenyye – promyshlennosti, nauke, tekhnologiyam i professional'nomu obrazovaniyu: problemy i novyye resheniya (Young scientists to the industry, science, technologies and professional education: problems and new solutions) Collection of scientific reports of the VII International Scientific and Practical Conference. — M.: MSIU., 2007. 624 p.

Another transport factor leading to a negative impact on public health is traffic-induced noise. Being the main source of noise in cities, motorised transport causes various painful reactions among the population. Road traffic is the major source of noise in cities with the noise level augmenting as the intensity and speed of traffic rises. According to the WHO, about 40% of the European population is exposed to traffic-induced noise with levels of more than 55 dBA LDN. Together with the general irritating effect, noise causes stress and a rise in blood pressure in exposed individuals. Stress increases the risk of cardiovascular diseases as well as resulting in sleep disorders, reduced rate of learning in children and ringing in the ears.

The noise level is influenced by a number of factors:

- traffic flow intensity (the highest noise levels are recorded in the main streets of major cities at a traffic intensity of 2.000 — 3.000 cars per hour);
- traffic flow speed (a gain in the speed of vehicles is followed by increased engine noise, the noise of wheels rolling on the road and air resistance);
- traffic flow composition (freight vehicles produce more noise than passenger traffic);
- engine type (diesel, petrol, electric);
- type and quality of road surface;
- spatial planning decisions;
- green spaces available (there should be sanitary protection areas with trees and bushes along highways in order to prevent the spread of noise to nearby areas).

Various measures can be taken to ease the negative effect of traffic noise, such as speed reduction, the redistribution of intense traffic flows in road networks to remove them from residential development zones, separation of flows by sanitary protection zones from residential areas, etc.

Promoting the widespread use of private vehicles for travel in cities along with a number of other reasons (widespread development of the Internet and its various services, automation of many labour processes, etc.) all lead to a high incidence hypodynamia among the population.

Around 1.9 million people die of hypodynamia and related diseases per annum. Hypodynamia is one of the causes of obesity, diabetes and depression<sup>89</sup>. With Melbourne used as an example, researchers from Australia showed that travelling by car costs society 19 times more than cycling<sup>90</sup>.

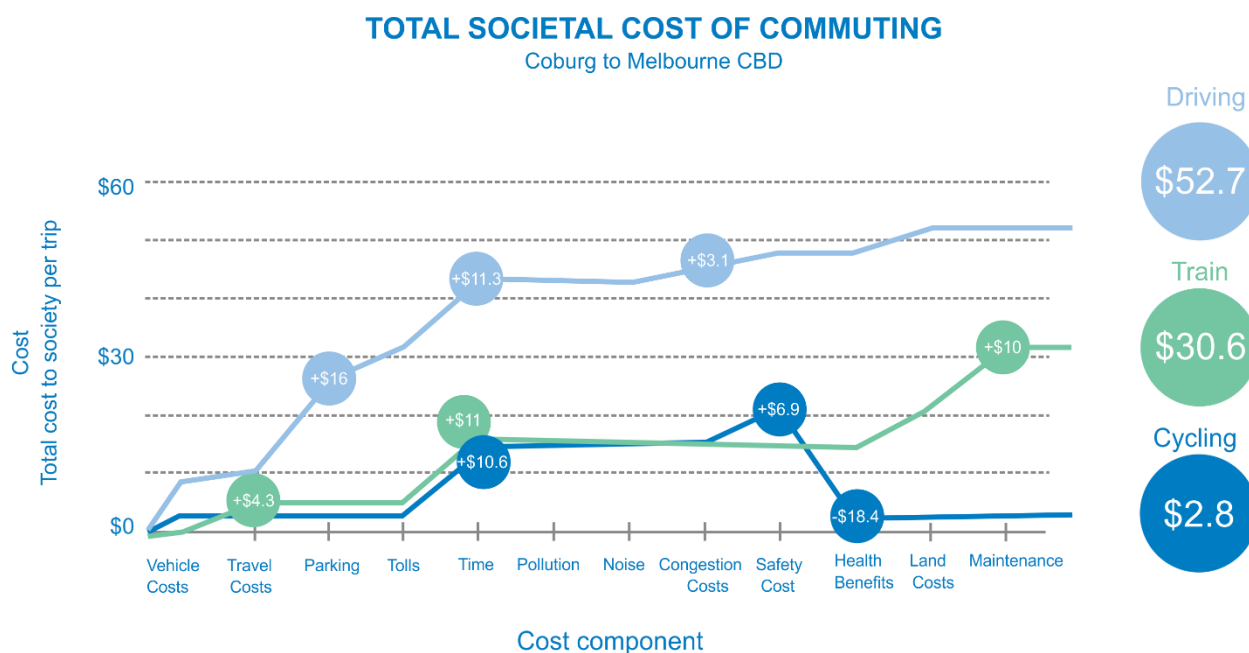
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<sup>89</sup> <https://www.newsru.com/world/13may2008/hypodinam.html>

<sup>90</sup> [http://blog.deloitte.com.au/divorcing-growth-car/?fbclid=IwAR059hS\\_5eSGJ-IUi9KkV57QGkS9hpy\\_nV56R6NXt\\_THK80eCmQzqQAhvIw](http://blog.deloitte.com.au/divorcing-growth-car/?fbclid=IwAR059hS_5eSGJ-IUi9KkV57QGkS9hpy_nV56R6NXt_THK80eCmQzqQAhvIw)



Figure. A study conducted in Australia used Melbourne as the premise for a comparison of cycling costs against motor vehicle use costs



## 4.2 Active mobility as an instrument of public health

### 4.2.1 Physical activity and health

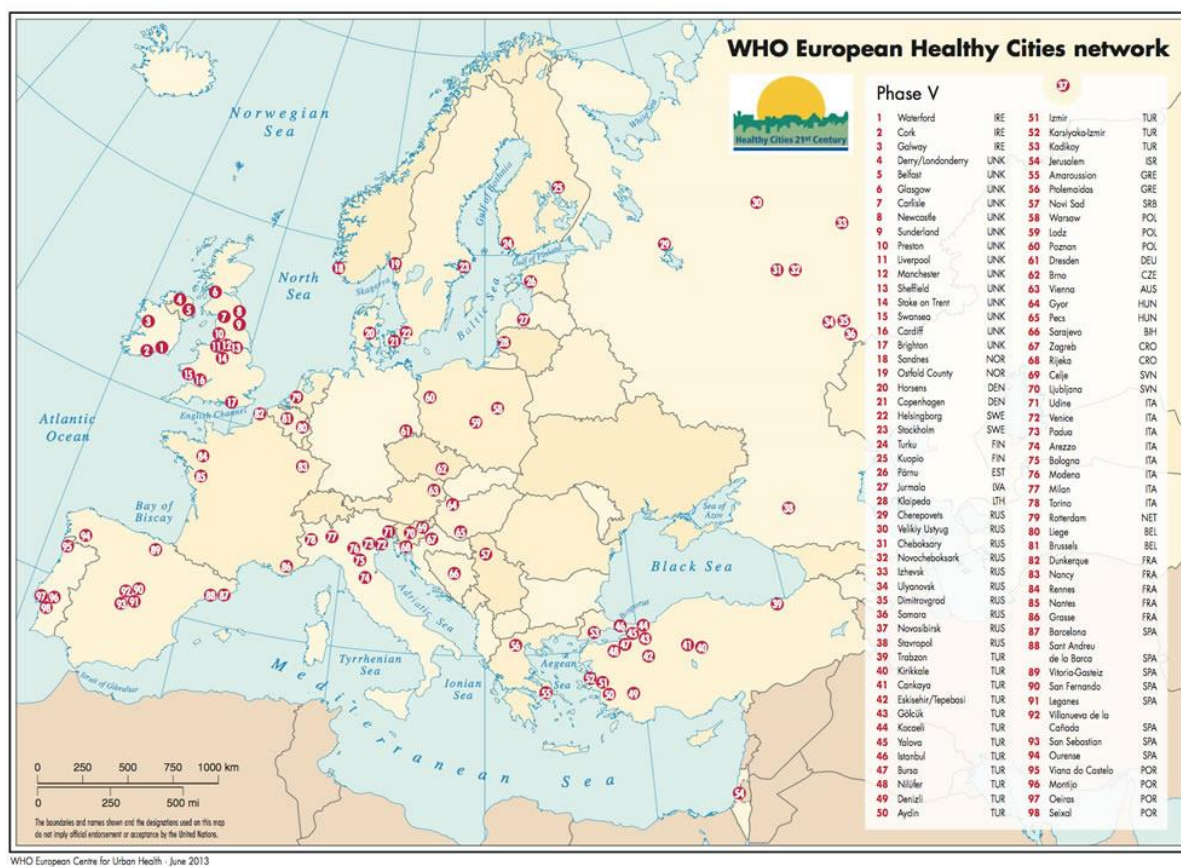
The WHO recommends a minimum of 150 minutes of moderate intensity, aerobic physical activity for adults per week. Statistics suggest that almost half of European citizens over 18 do not partake in this type of activity at all. In 13 out of 26 EU member states, the proportion of individuals who did not spend any leisure time exercising exceeded 50%. Countries such as Denmark and Finland fair slightly better with 19.3% and 23.3% respectively whilst Greece, Bulgaria and Romania report numbers well over 50%.

Physical activity (PA) levels in the EU are affected by a number of factors such as age, gender, education and income. Generally, men are more physically active than women, and the same can be observed for those with higher levels of education and income. Even a moderate amount of PA can be hugely beneficial one's health over a lifetime. More specifically, physical inactivity has been linked to cardiovascular disease, strokes, obesity, type 2 diabetes, cancer and poor musculo-skeletal and mental health. PA has been shown to contribute to the prevention of these non-communicable diseases as well as promote weight loss, thus decreasing the risk of obesity.

The importance of PA in relation to human health has been long recognized by planners and policy makers alike. For example, the EU Platform for Action on Diet, Physical Activity and health was launched in March 2005 with intention of tackling rising obesity levels in Europe. Aside from addressing nutrition, the initiative specifically focuses on the promotion of physical activity as a measure to promote healthy lifestyles.

HEPA Europe (European Network for the Promotion of Health-Enhancing Physical Activity) is a network which works for better health and wellbeing in the European region through the promotion of PA. All the activities of HEPA are based on WHO policy statements such as: the European Strategy on Physical Activity, the Global Strategy for Diet, Physical Activity and Health and the NCD Action Plan. Corresponding documents from the European Commission were also utilized.

**Case study: the World Health Organization Europe’s Healthy Cities Network, a regional-local approach**



- The WHO Europe’s Healthy Cities programme which started in 1998 fosters health and well-being by improving urban planning to create better urban areas to live, by increasing community empowerment and participation to improve social cohesion, and by investing in people for a peaceful planet. The European network operates in 30 countries via 1300 Healthy cities covering approximately an urban population of 250 million people. A key feature of a Healthy Cities approach is to try to integrate health into all local policies, including transport.
- The aim of the WHO French Network of Healthy Cities is to promote exchange between municipalities and agglomerations who wish to develop healthy public policies. It has nearly 100 cities-members covering a population of 14 million people. (Zoe Heritage)
- In order to develop active mobility with health, transport or even tourism objectives, the local authorities have many strategies available, such as environment, education, planning, etc. This will involve several local city councillors and services cooperating together.
- As physical activity is a major determining factor in of health, active mobility can be included in local health policy frameworks, such as Local Health Contracts.

**4.2.2 Physical activity and active mobility**

Regarding Active Mobility, 78.4% of Europeans spend at least 10 minutes of continuous walking to get to and from places in a typical week. This encouraging number demonstrates the Importance of this activity as a means of promoting health and reducing sedentary behavior. The WHO along with health professionals have led the way in terms of tackling physical inactivity and health problems through the promotion of Active Mobility.

Global trends in urban planning and policy have seen more efforts directed toward the development of sustainable urban mobility plans and more livable cities. One of the central

components of Sustainable Urban Mobility Plans (SUMP) is a balanced and integrated development of all transport modes. Increasing Active Mobility which includes walking, cycling and the use of public transport, frees up urban space which would normally be occupied by motorized transport infrastructure. Aside from this, it also reduces energy use as well as air and noise pollution. Perhaps most importantly, Active Mobility provides an opportunity to tackle and reduce illnesses and other negative side effects of sedentary behavior and general physical inactivity.

The promotion of walking and cycling individually or in combination with public transport present an excellent opportunity to incorporate PA into daily life. This is because mobile Europeans spend on average 70-80 minutes per day travelling. In addition to this, 50% of all car trips are shorter than 5kms. This contrasts with sport and exercise which requires more time, effort and motivation. The convenience and affordability of Active Mobility give it the potential to reach sectors of the population less receptive to appeals to take part in sports and exercise. This is particularly true in the case of sedentary, obese or elderly people.



**Illustration. Citizens of Copenhagen (Denmark) ride the bicycle not for entertainment, but for personal and work/school trips, all year round**

Copenhagen (Denmark) has long been a role model for cities striving to develop cycling. Copenhagen takes its cycling infrastructure very seriously.

All cycling routes (more than 28) going from the suburbs to the city centre are structurally segregated from the roadway as opposed to just being drawn on the edge of it.

The capital region now boasts more than one thousand kilometres of dedicated cycling paths and several hundred kilometres of cycling lanes. Investments in cycling infrastructure can be explained not by environmental concerns, but by mere financial gains. The cost of one kilometre of a cycling path pays off after five years thanks to the improved health of those who regularly use it. Road traffic on these segments of the road is reduced by 10%, with cycling traffic going up by 20%. Approximately 41 percent of citizens travel to work or school by bicycle. They save the state budgets a tremendous amount to the tune of 235 million euros per year.

*“41% of people in Copenhagen get to and from work by bicycle. They save the state budget 235 million euros per year.”* Mikael Colville-Andersen, The Guardian.

Copenhagen has the most law-abiding cyclists in the world: only 7% of them violate traffic regulations to some extent with only 1% committing gross violations, for example, running a red light or riding on the sidewalk. The good design in place encourages compliance with the rules. According to the Copenhagen authorities, compelling cyclists to comply with the rules is a very simple task, all it takes is a good infrastructure to be built for them (to separate the cycling paths from the car flow and pedestrian sidewalks) and a place in the urban landscape.

With a safe environment created, the general population is encouraged to cycle. First of all, this is achieved through dedicated infrastructure and attaching higher priority to the bicycle as a mode of transport.

A sense of safety is no less important than safety itself for the citizens of Copenhagen. Citizens in a city should both feel safe and be safe.



Copenhagen adopted the concept long ago. The city has built an infrastructure suitable for 99% of the population, not just for those who cycle around wearing fancy cycling shorts. The infrastructure is being put in place not for those who already cycle but for all who could cycle, i.e. for all people regardless of the age and income level<sup>91</sup>.

Successful examples of that are also found in other European cities. Only ten years ago, cities like Paris, Seville, Barcelona, Bordeaux and Dublin had next to zero cyclists. Nowadays, however, these cities have undergone upgrading and gone back to cycling in which process they are aided by the right infrastructure in combination with measures taken to slow traffic, tighten speed limits and provide an effective bike rental system.

#### **4.2.3 Enabling factors, barriers and challenges for active mobility (AM)**

The primary enabling factors for the successful promotion of active mobility are strategies, visions and policies driven by political buy in at governmental level. A setting of environmental targets, increased road safety and a general awareness of the benefits of active mobility for health are also strong success factors. In addition to this, Urban mobility plans, cycling concepts and additional Active Mobility measures and interventions further promote successful uptake.

On the other hand, the promotion of Active Mobility involves numerous challenges and barriers. A lack of political will driven by a fear of losing car driver votes has thwarted previous Active Mobility schemes. Lack of available budget and limited space as a result of the prioritization of motorized transport present further hurdles. Limited collaboration between local and national government departments, planning sectors and stakeholders combine to add conditional constraints to initiatives. Whilst a lack of pedestrian and cycling infrastructure and an underdeveloped cycling culture provide obvious roadblocks to AM promotion.

Transport and health policy have a very clear connection as they both aim to create environments and settings where human behavior can be influenced. Transport and urban planning have an impact on peoples travel behavior whilst health policy aims to promote physical activity as a means of preventing non-communicable diseases. Active Mobility serves as the interface between these two sectors. Aside from health benefits, AM reduces congestion, pollution and emission levels and contributes to healthier and more social urban environment.

The WHO understands and addresses the link between AM and health in their 'Health in all Policies' approach. This is a framework based on the acknowledgement of the fact that a healthy population can only be achieved through combined effort and consideration across all fields of policy. Although this important connection is understood by stakeholders and policy makers, the health benefits of PA and AM are often not prioritized in planning. They are often viewed as a welcome side effect of efforts to tackle other issues such as congestion.

The Health Economic Assessment Tool (HEAT) online tool was developed by the WHO in collaboration with experts to estimate the economic value of reduced mortality rates as a result of increased AM. The tool is intended to be incorporated into a comprehensive cost-benefit analysis of transport interventions or infrastructure projects. This includes assessing the current status of transport and previous investments. HEAT is also complementary to existing economic valuation methods for transport interventions aimed emissions or congestion. The default parameters for this assessment are based on the European context however they can be adapted to fit specific situations.

HEAT<sup>x</sup> calculates the impact of transport related variables on the economic value of mortality rate improvements. For example: if x people cycle or walk y distance on most days, what is the economic value relative to mortality rate? It can be applied within multiple contexts such as for the planning of new cycling or pedestrian infrastructure or the value of cycling promotion schemes for a specific workplace.

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<sup>91</sup><http://letsbikeit.ru/2015/02/copenhagen-cycling-innovation/>

## Case study. The PASTA Project: promoting physical activity through sustainable transport



The PASTA (Physical Activity Through Sustainable Transport Approach) project was a 4-year EU co-funded initiative which aimed to bridge the gap between transport and health by encouraging active mobility in cities. This innovative approach attempted to circumvent resistance to exercise through the incorporation of physical activity into daily life. The main objective of the project was to develop a Health Impact Model (HIM) for Active Transport (AT) which builds on and contributes to already established models. Other objectives include identifying the key determinants of AT behavior, understanding how AT relates to

Physical Activity (PA) and, measuring the effectiveness of efforts to promote AT. 7 European cities were selected as case studies for the project including: Antwerp, Barcelona, London, Örebro, Rome, Vienna and Zurich. The PASTA project followed the TAPAS- Transportation, Air Pollution and Physical ActivitieS ended in 2013). The TAPAS research programme was designed to help decision makers design urban policies that address climate change and also promote other health-related outcomes.

The PASTA project involved developing a set of qualitative and quantitative indicators to assess and measure the state of active mobility in European cities. This was achieved through extensive interviews and workshops with practitioners from the 7 selected case study cities. The selected indicators include the following: modal share of cycling and walking, cycled or walked kilometers per year, current awareness to active mobility, land use and topography, policies for active mobility and political support. The development of an indicator set such as this one assists planners and decision makers with understanding active mobility as well as the conditions which constrain and support it within an urban context.

A series of workshops and interviews with practitioners from the transport and health sector were then carried out in the case study cities. The intention of this process was to examine the link between the promotion of active mobility and the overall health levels in towns and cities. In addition, the cooperation between diverse sectors and city departments covering health, urban planning and transport was also explored.

The outcome of the project was an updated version of the World Health Organization's Health Economic Assessment Tool (HEAT). Which is a tool designed to assist urban planners as well as transport and health practitioners with garnering support for greater investment in active mobility. A further outcome was the documentation of good practice case studies from across Europe.

### Case study. The SWITCH project: embracing active travel for health

The EU funded SWITCH project aimed to increase AM, reduce GHG-emissions and primary energy consumption as well as generally contribute to higher quality of life in cities. Ended up in 2016, this was achieved by assisting planning and transport practitioners to conduct professionally organized campaigns to encourage people to “switch” from cars to active modes when making short trips. This change was beneficial to public health as well as to public transport operators as AM is easily combined with bus or rail trips.

SWITCH campaigns had been implemented in Antwerp, Donostia / San Sebastian, London Hounslow, Gdansk and Vienna involving 11,000 participants, for an overall budget of 1,63 million € (1,27 million € from EU funds).

The focus of a SWITCH campaign is to get people to exchange short car journeys for active modes. Therefore, the primary of beneficiaries of the program were car users. The primary target audience of campaign guide were practitioners in the field of urban transport planning as well as public health. Well established behavioral change approaches were used to develop the four core elements of the initiative:

- Personalized Travel Planning
- Arguments from Public Health
- ICT applications
- Actions applied to people in a period of life change, e.g.: new home or new job

These four elements were varied and tailored for the varying and unique contexts in which they were applied. Personalized travel planning (PTP) involved a form of communication called ‘dialogue marketing’ which involves on close, tailor-made contact with targeted individuals in order to promote a change in travel behavior.

Information and Communication Technology tools can be valuable for a SWITCH campaign for the collection of travel and activity data as well as to support behavioral change. ‘Life change moments’ present opportunities for behavioral change as they are instances where individuals are often forced to reflect about their routines and behavior. Examples of ‘Life change moments’ include moving homes or to a new school or even getting a poor health diagnosis. When this happens, people are more susceptible to targeted campaigns.

The SWITCH campaign consisted of several phases:

- Recruitment: Defining the target group and obtaining contact data.
- Contact: Face-to-face or indirect contact.
- Baseline Survey: Learn about current mobility behavior through face-to-face, online or telephone surveys.
- Segmentation: Filter out people who do not match target group specifications.
- Motivation: motivate people to participate through incentives. Offer information/advice on “service sheet”.
- Advice: provide individualized advice along with continued support and encouragement.
- First After-Engagement Survey: measure short term behavioral change.
- Second After-Engagement Survey: 4-6 months after the campaign, measure long-term behavioral change.





**Table. The SWITCH project in Donostia/San Sebastian, Basque Country, Spain**

<b>Results</b>	<b>Before the campaign</b>	<b>Shortly after the campaign</b>	<b>3 months after the campaign</b>
Participants	532	490	471
Car use	21.6%	21.1%	9%
Cycling	9%	10.1%	6.5%
Awareness of health benefits of active travel	99%	99.6%	99.6%
Participants having access to a car and who reduced car trips		107	5
<b>Participants walking (at least once a day)</b>	<b>54.9%</b>	<b>54.2%</b>	<b>68.8%</b>

Donostia/San Sebastian is an example of a city that successfully implemented the SWITCH program. The city is the capital of the Gipuzkoa province in the Basque country. Its wider metropolitan area is home to 485 000 inhabitants. The main economic activity of the city is tourism. The city has adopted an urban mobility strategy that prioritizes active travel modes. It boasts 65kms of cycle lanes and connections between the urban regional network which provides access to the rest of the province. There is a well-developed public transport service with a high usage rate and regular upgrades to its bus fleet which includes some electric and hybrid vehicles. In response to increasing car usage in previous decades the city implemented an urban conversion program to thwart this trend and maintain a people friendly environment. As a result of these efforts, pedestrian modal share has remained high followed by public transport and cycling.

The selected target groups for the implementation of the SWITCH campaign in this context were: people who had recently moved homes, changed their educational status or been advised to increase their physical activity for medical reasons. Some of these groups, including individuals who had recently moved home were recruited by way of the municipal census department. These attempts were further supported by the Culture and Diversity department which was already running a welcome campaign for all new residents in Donostia. Gaining access to people who had changed their educational status was facilitated by the chancellor of Gipuzkoa’s campus. Reaching individuals who had previously received medical advice proved more difficult as medical staff tasked with conveying information about SWITCH often did not have enough time to do so during consultations. An alternative recruitment approach was developed which involved info days at various medical centers.

Campaign participants were provided with incentives which included one out of four gift options: stepcounter, cycle torch, cycle bell or drink bottle. At the end of the campaign a raffle was organized in which all participants had the opportunity to win folding bicycles, “smart” wristbands and annual tickets for the city’s e-bike sharing system.

A mobile app was developed to track participants travel behavior. This application was based on the already existing “Moves” app with some minor language adjustments. Most participants requested specific assurance that the app was only able to measure distances and not record locational data. People who were more familiar with mobile applications appreciated the new source of information and provided positive feedback. In general, most participants reported that they preferred paper-based trip documentation. It is therefore recommended that ICT tools be considered as complementary rather than primary data collection methods.

### Case study. The Wales Active Travel Act (2016)

To increase AM and reap its numerous health and societal benefits, the Wales government implemented the Active Travel Act (2013). The act focuses on walking and cycling as transport modes and does not cover recreational or competitive walking and cycling. This piece of legislation makes it's a legal requirement for local authorities in Wales to map and plan for suitable routes for active travel. In addition to this, they are obliged to upgrade their pedestrian and cycling infrastructure on a yearly basis. Public health dimension of AM is the primary driver for the Act and wider objectives related to well-being, physical activity, behavior change and road safety. The act highlights the important role played by good quality infrastructure networks as well as the need to incorporate the health dimension into transport planning and legislation.



The act was implemented in September 2014 after being submitted for public consultation. The Minister for Economy, Science and Transport was played and instrumental role in the deliverance of the Act into legislation. Under the Act authorities were required to prepare and publish maps of existing travel routes as well as maps of integrated networks for specified settlements linking services and residential areas. The new proposed plans would have the purpose of encouraging active travel as an option for short journeys. The mapping process was supported by £ 300 000 of funding from local authorities.

The integrated network map lays out the plans of the local authority over a 15-year period. All practitioners involved in the planning, design, approval, construction and maintenance of the active travel networks and infrastructure are tasked with providing design and delivery guidance for local authorities. The funding of the new routes was secured by redirecting spend previously allocated to cycling and walking as well as through sponsorship with the private sector.

The Active Travel Action Plan was published in February 2016 to complement the implementation of the Active Travel Act. This was done through setting out wider actions across a broad range of government departments to increase AM levels across Wales. It includes 28 actions under 6 themes which are summarized below (see Annex to Chapter 5)

Infrastructure grants to local authorities totaling over £11m have been awarded for active travel schemes for 2016-2017 by the Cabinet Secretary for Economy and Infrastructure's budgets. This includes £5m for the Safe Routes in Communities Grant. Thirty schemes across Wales have benefited from funding to make improvements to local active travel infrastructure focused around schools. In addition, nineteen local authorities have received a Road Safety Capital Grant of over £2m for schemes making improvements for walkers and/ or cyclists.

The Welsh Government's Rural Development Program is providing funding for a "Development of the Walking and Cycling Network in Rural Wales" project. The project has already identified eight schemes across Wales to fill key gaps in the national walking and cycling network. These developments open new opportunities for local people to access jobs, services and tourist destinations using active transport.

**Table: key indicators of the impact of the Wales Active Travel Act measured in 2016**

Indicator	2016	2018
The proportion of the population (aged 16 and over) who use a bicycle for active travel at least once or twice a week	5%	6%
The proportion of the population (aged 16 and over) who walk for active travel purposes at least once or twice a week	61%	58%

The proportion of the population (aged 16 and over) who use a bicycle for active travel purposes at least three times a week	3%	2%
The proportion of the population (aged 16 and over) who walk for active travel purposes at least three times a week	47%	-
The proportion of primary school children who typically walk or cycle to school.	43%	-
The proportion of secondary school children who typically walk or cycle to school.	35%	-
The number of seriously injured road pedal cyclists admitted to hospital.	236	225

The key requirement of the approach adopted by the Wales Travel Act (2013) is the continuity of walking and cycling route networks. Integration with public transport is necessary in order to generate additional movement and enable multi-modal mobility. A wide range of policy areas including public health should be benefitted by AM. In conclusion, coordination across government and local authorities is required to support and promote active travel.

The Utrecht Healthy Urban Lab, the Barcelona superblocks, the sets of measures and initiatives in Vienna to encourage walking show that the promotion of active mobility and the connectivity between *active mobility* and *public health* is now a widespread concern in cities among UNECE countries.<sup>92</sup>

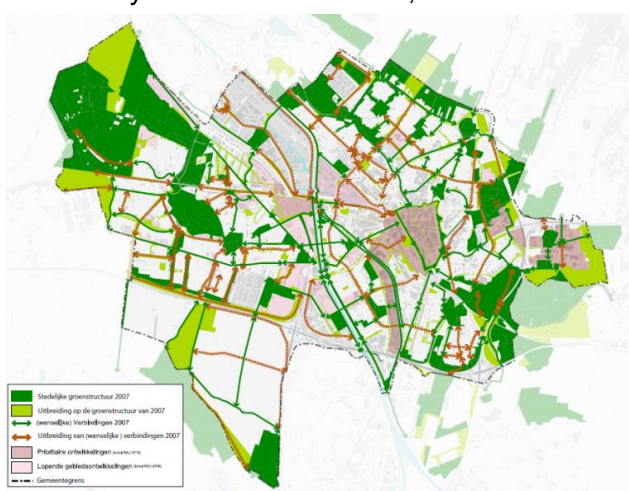


Illustration. The Healthy Vision Green Structure Utrecht 2030 (March 2018)<sup>93</sup>

### 4.3 How can cycling (and walking) pay off

*“Annual investments of 400-600 million euros in cycling pays off for the Netherlands by more than 18 billion euros per year in health care alone”<sup>94</sup>.*

#### 4.3.1 Cycling in a co-modality perspective

*“In cities with good bicycle infrastructure, public transport is also excellent. Perhaps the thing is that when the city administration begins to calculate the capacity of streets not in terms of privately owned cars, but in people, the most natural thing is to construct cycle lanes or public transport dedicated lanes.”<sup>95</sup>*

<sup>92</sup> Utrecht: [http://www.polisnetwork.eu/publicdocuments/download/1364/document/linssen\\_healthy-urbanization-utrecht\\_eandh-wg-08042014.pdf](http://www.polisnetwork.eu/publicdocuments/download/1364/document/linssen_healthy-urbanization-utrecht_eandh-wg-08042014.pdf). Barcelona: <http://www.bcnecologia.net/en/conceptual-model/superblocks> ; [https://www.c40.org/case\\_studies/barcelona-superblocks](https://www.c40.org/case_studies/barcelona-superblocks). Vienna: <http://newsletter.wienzufuss.at/11jGm0GuqDg7R2uXOZ>

<sup>93</sup> Utrecht Green Structure Plan actions aim at sustainable urbanisation: less and slower traffic, climate- and energy-neutral construction, efficient water management and green areas for pleasant and healthy urban living.

<sup>94</sup><https://ajph.aphapublications.org/doi/abs/10.2105/AJPH.2015.302724?journalCode=ajph&fbclid=IwAR3RJeLUt6op0PiF9lh4LzyBzu8NwKgp063UkXn2Ar85Z3T7JNJTtKSJg>, American Public Health Association — Dutch Cycling: Quantifying the Health and Related Economic Benefits

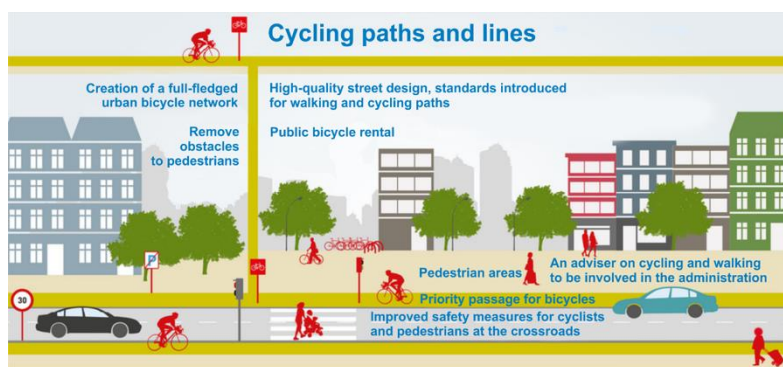
<sup>95</sup> *Copenhagenize*. Mikael Colville-Andersen



In cities, users are seen choosing between modes of transport or a combination thereof guided by criteria such as cost, accessibility, time of travel, comfort of travel, number of transfers, etc. However, environmental and safety requirements are often not sufficiently taken into account by users in planning their trips. In view of that, the authorities are faced with the goal to provide users with the safest and best quality alternatives in their choice of travel/transport planning options.

In 2006, the European Commission (EC) introduced for the first time a new concept of “co-modality” into transport policies to define a global approach to the choice in modes of transport and their combinations. Co-modality was understood to mean *“use of different modes on their own and in combination” in the aim to obtain “an optimal and sustainable utilisation of resources”*.

The concept of co-modality mass transit implies the construction of urban transport systems combining priority development and joint use of mass passenger transit (public passenger transport), collective use systems for passenger transport, various types of small electric mobility and various types of active mobility.



**Illustration. Encouraging cycling and walking in cities<sup>96</sup>**

Co-modality (intermodality) means the creation of an integrated mobility system that promotes synergy between multiple modes of transport. There are two key benefits from combining cycling and public transport. Firstly, it creates a bridge between two important

transport modes that together offer sustainable transport from door to door for longer distances. It provides a solution to many PT users to shorten the first and last miles to and from PT stops and hubs. Secondly, as it was told earlier, it adds the health benefits of physical exercise to the daily life of people even if most of the distances are travelled by PT.

In order to improve intermodality between PT and cycling it is vital to connect train stations and PT hubs to a complete network of cycle routes in the city and create bicycle parking facilities in key locations around the PT network. PT organizations and companies should offer accessible services and information for cyclists as part of their services to the customers. PT ticket systems need to offer financial incentives and tickets that promote flexible mobility such as the inclusion of bicycle rental schemes and bicycle parking. But even when not combined with PT, cycling still solves problems of congestion, traffic and overcrowded PT. This demonstrates the flexibility and efficiency of cycling as a mode of transport.

A viable alternative to private vehicles represented by reliable public transport serves to cut down the number of individuals prone to private car use while contributing to the growing number of multimodal trips with individuals combining cycling with other modes of transport. On the other hand, the creation of an efficient cycling and walking infrastructure in cities establishes an enabling environment for the development of public passenger transport.

There are two positive aspects to the use of “active modes of transport” (cycling and walking, scooters, skates, roller skates, etc.) - firstly, it curbs the use of other modes of transport (mostly, private motor vehicles), thereby reducing the burden on the urban transport system, cutting

<sup>96</sup>[https://sutp.org/files/contents/documents/resources/J\\_Others/GIZ\\_SUTP\\_Infographic-10-Principles-for-Sustainable-Urban-Transport\\_ru.pdf](https://sutp.org/files/contents/documents/resources/J_Others/GIZ_SUTP_Infographic-10-Principles-for-Sustainable-Urban-Transport_ru.pdf)

down the emissions of pollutants, noise, etc., and, secondly, it enhances the physical activity of the population thus reducing morbidity and mortality resultant from lack of physical exercise.



**Illustration. The comprehensive benefits of cycling**

Active mobility can be used both independently (for cycling trips up to 3-5 km and walks up to 1-2 km) and as part of combined (intermodal) transport chains, especially in conjunction with public transport. If transport correspondence end points are close to each other, travel distances to be travelled will be short and the way to cover them will be by non-motorised

ways (for example, by bicycle or on foot). This usually happens in the city centre and other places of concentration of urban activity. However, in large cities with long distances of travel, there is a need for high-speed urban transport where different modes of transport, including cycling and walking, are efficiently integrated.

**Illustration. Winter bike parade in Moscow (Russia)**

Seasonality and weather are believed to have a strong influence on cycling, but this is often not the case. For example, in the Yukon Territory located in northern Canada, there are two times more people cycling than in California whereas in hilly San Francisco, there are twice more cyclists than in relatively flat Denver. Climate, terrain and other factors cannot be viewed as insurmountable obstacles to driving up the number of cyclists as the facts bear out the opposite.



In the Netherlands, 36% of people choose the bicycle as their main mode of transport with this figure even higher in cities. In Amsterdam, nearly 60% of journey's are made using cycling or walking. Copenhagen, another role-model city for cycling, also boasts a rather low level of car ownership, especially for a city with a per capita GDP of over \$25,000. Total cycle ridership is over 2 million km / day and the city also has the second highest penetration of share-cars around the world. In Copenhagen, which has invested \$150 million in cycling in the past decade alone, 62% of people go to work or school by bicycle — 7 times more often than by car. Copenhagen is known for the fact that during snowfalls municipal vehicles first clean the cycle lanes, and only then the motorways.



**Illustration The logo of the VeloCity 2019 conference in Dublin (Ireland), now a significant international event, organised by the European Cyclists' Federation**

There are many reasons why Copenhagen has such a high share of bicycle trips. The city has a long cycling tradition, which is recognized and accepted as a part of the daily life-style and routine of many citizens. Cycling is well incorporated in the traffic planning, having taken this into account and reacted accordingly over the years to cater to the increasing number of cycle users by initiating relevant infrastructure developments.

Today, the cycle network stretches over 410 km in an area of about 90 km<sup>2</sup>. Furthermore, the city is improving its cycling conditions by the use of innovative transport planning instruments and the constant optimization of demand-oriented measures eg.:

- Constant appraisal of the current cycle situation by surveying and counting
- Frequent optimization and extension of the cycle network by establishing of missing cycle tracks and maintenance of existing (sub-)urban cycle tracks
- Widening of cycle tracks as a reaction to existing and future bicycle traffic demands
- Measures to accelerate the cyclists to minimize their average journey time (e.g.: making them part of "green routes", prioritization on intersections, green waves for cycles, Bicycle Commuter Superhighways)
- Establishing infrastructure for cycle parking: bicycle-parking houses (Commercial: 0.5 bicycle parking spaces per employee / Residential: 2.5 bicycle parking spaces per 100 m<sup>2</sup>)
- Easier intermodal transfers between bicycles and public transport
- Additional services and innovations, to aid cycle usage in general (e.g. LED warning sensors on special intersections, footboards in front of traffic lights, air pump stations).

#### 4.3.2 Integrated cycling and walking friendly infrastructures at city and metropolitan-region scales

Leading European countries such as Denmark and The Netherlands are no longer the only countries with developed cycling policies. Many cities have recognized the importance of cycling and are integrating this mode into their sustainable mobility plans. Cycling is a good feeder system for public transport and therefore the link to public transport (PT) is a key feature for cycling as a system.



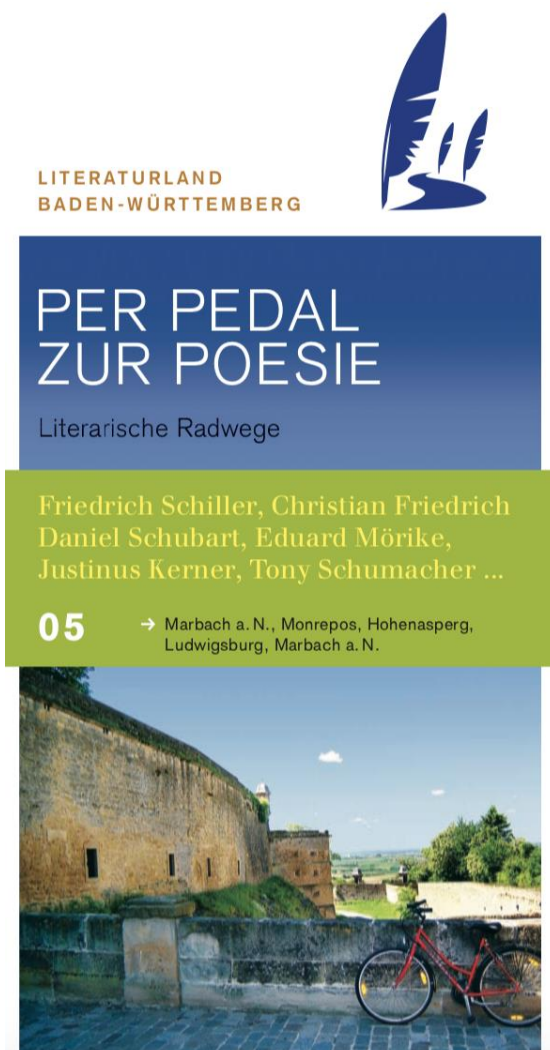
#### Case study. The project of bicycle superhighway in the Ruhr Region (Germany)

In 2015, the German Federal Ministry of transport launched a plan to create a «bicycle superhighway» of over 100 km to connect 10

cities and 4 universities in the densely urbanized and otherwise car-centred Ruhr region. The idea sparked in 2010 after more than 3 million people went down a portion of road between the cities of Duisburg and Dortmund closed for a cultural event. «Coupled with Europe's blossoming affection for electric bikes and Germany's limited proximity between cities, the Radschnellweg stand to attract a new wave of pedal-powered commuters. Frankfurt, Hamburg, Berlin, Munich and Nuremberg are also undertaking bike-related feasibility studies



in order to curb traffic and pollution in those urban areas»<sup>97</sup>. This project is targeting to pull over 50,000 cars off the roads.



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05

→ Marbach a. N., Monrepos, Hohenasperg,  
Ludwigsburg, Marbach a. N.



Similar initiatives are also under way in other parts of Germany, be it München in Bavaria or Berlin, where Berlin's Senate Department for Environment, Transport, and Climate Change estimates that currently half of the journeys taken in Berlin are under 3.1 miles, but a third of these journeys are undertaken by car. While Denmark has focused most of its efforts on Copenhagen, the Netherlands have started building a network of over 20 bikeways in the beginning of the 2000's. Besides, Norway has also announced its will to create bikeways connecting 9 cities. The theme of cycle highways is regularly gained traction and for instance, it is one of the main topic of *VeloCity* 2019 in Dublin.

**Illustration: the development of intercity cycling routes to support sustainable tourism. The example of poetry routes in Baden Württemberg, Germany. Source: Baden Württemberg Literarische Redwege**

### Case study. Münster intermodal policy

At the other end of the route, bicycle stations are a crucial part of long term attractiveness of new cycle infrastructures. In the city of Münster (Germany), more than 2,000 people switched from other modes to cycling after a brand new and convenient bicycle stations was created near the central railway station, meeting a high demand from commuters for quality bicycle parking spaces. The bicycle station provides parking

space for 3,300 bicycles and it is divided in different sections referring to daily-, monthly-, annually- and long-term-parkers. Today almost all available spaces for parking situated outside the bicycle station are occupied with around 3,000 bicycles. The underground bicycle station itself can be reached by a big ramp and by two steps, one leading directly into the central station and the other one into the adjacent pedestrian area.

The Münster case is a good example of the need to develop quality *mobility points* to give uncomplicated and fast access to low-emission mobility around the clock. It can be a central facility in a new urban development area or strengthen structures in existing neighborhoods. A variety of vehicles and services can be booked and used. This way, mobility services can be bundled in a well-structured way in one place, which is particularly important in new urban development areas. These are the potential services offered at a mobility point:

- bike sharing (station of the city system or local initiative);
- car sharing (parking spaces for various providers and local initiatives);
- single-track vehicle sharing stations (e.g. e-scooters, motorcycles) and stations for other, emission-free means of transport (freight bicycles, e-bikes)
- delivery service infrastructure (community mailboxes, lock boxes for interim storage, cooling boxes)

<sup>97</sup> Kelly Mc Cartney, *Ecowatch*, July 2016

- IT infrastructure (computer terminal or the like) for vehicle hire, enabling of use, lock box allocation, delivery notes etc.
- bicycle repair and service workshops - charging stations (e.g. for electric bikes and scooters or mobile hand-held devices which can e.g. be used for accessing dynamic real-time transport information).

### Case study. Promoting pedestrian trips in French cities



France is experiencing several initiatives to promote walk, such as the walking buses to school or the pedestrian's signs including walking time.

**Illustration: signage for pedestrians showing distances in minutes in Grenoble (France). Photo: enviro2B.com**

Inspired by the experiences of the Nordic and some English-speaking countries, around 350 French cities have created school walking buses. The walking bus is an eco-citizen

mode of transport based on parents or other community members providing pedestrian accompaniment to groups of children, from home to school, on safe, marked out routes. There is a "timetable" where the bus leaves the neighbourhood "stops" as a set time in the morning. It leaves the school after the last lesson when all "passengers" are ready.

As well as improving the children's health and reducing motorised traffic and pollution, the walking buses teach children how to behave safely on public roads, it provides fun, and reinforces social links between children of different ages.

The city centres tend to be more and more pedestrian and yet many urban dwellers still choose to get about using individual motorised transport. The main criteria when choosing a mode of transport for daily journeys is time and the ease of signalling to indicate how to get from one place to another. Pedestrian signs with walking times expressed in minutes help to show that many places "are closer than we think".

Public Health France has piloted an experiment in 9 cities. An evaluation of the signage showed that 91% of inhabitants appreciated the new pedestrian signs and 86% said they would use them. Since the pilot scheme there has been exponential number of French towns and cities putting up 'timed' walking signs. For example, Grenoble city council has put up 270 signs on 30 kms of streets and plans to further expand the scheme<sup>98</sup>.

### Case study. "My street" project in Moscow

In Moscow, the implementation of the project "my street" includes the promotion of alternative mobility ways including walk and cycling. 327 squares, highways and public spaces have been undergone improvement and reconstruction, including

- additional illumination for pedestrians, crossings and approaches to them,
- safety islands put in place to act as measures to calm vehicular traffic in places where unsignalled pedestrian crossings are located,
- re-engineering unsignalled pedestrian crossings into signalled ones,
- putting in place "elevated" pedestrian crossings,

<sup>98</sup> Based on the answers given by France to the UNECE questionnaire.

- widening sidewalks in the area of crossings (creating “ear-shaped spaces”) thereby reducing the length of crossings and improving pedestrian-driver visibility,
- imposition of speed limits in areas of cyclist and pedestrian traffic, including by forcing speed limitation by installing humps.
- Quality public space<sup>99</sup>.



**Case study. The programme on Promotion of cycling and cycling infrastructures in Almetyevsk (Russia, Republic of Tatarstan). Illustration: a bike festival in the street in of Almetyevsk**

In Almetyevsk (Republic of Tatarstan, Russian Federation), the municipal government is implementing a special programme on “*Promotion of cycling and development of cycling infrastructure in the municipality of Almetyevsk for 2016 - 2020*”.

The launch of the project was preceded by major efforts aimed at studying the public opinion about the current situation and prospects of cycling development. Respondents aged 15 to 60 and older participated in the survey. The results of the survey revealed that more than 22.000 bicycles were owned in Almetyevsk with the owners eager to put them to active use for trips around the city but the high intensity of car traffic coupled with the lack of bicycle infrastructure posed a very high risk to their health. Copenhagenize Design Co., based in Denmark with international experience in cycling, was contracted to provide more professional insight for the implementation of the project.

Between 2016-2018, 90 km of cycling paths and 37 km of adjacent sidewalks were built. Under the project, bicycle traffic lights, bicycle handrails, road signs, cycle metres, bicycle parking lots were installed and road markings were put in place<sup>100</sup>.

Similarly, The Tuymen city administration has also designed a concept to develop a network of cycling paths in the city and took measures to build bicycle infrastructure, now totalling 56,27 km (out of a total of 195,30 km planned new cycling routes)<sup>101</sup>. This cycling program is part of a wider “smart transport” policy, with buses and trolleybuses have been equipped with the GLONASS system that allows for monitoring of transport vehicles on the line, full control of transport vehicles, maintaining the interval between buses and trolleybuses and safety of operation by preventing stalemate situations.<sup>102</sup>

Centre for Operational Monitoring of Transport Vehicles on the Line has been created. Automated reporting systems have been installed on vehicles, as well as Automatic Fare Payment System and contactless payment, including NFC payment, that is, payment by phone<sup>103</sup>.

<sup>99</sup> According to the response of Moscow (Russia) to the UNECE questionnaire. More information about the urban improvement projects carried out in Moscow can be found at: <https://www.mos.ru/city/projects/mystreet>

<sup>100</sup> Based on the answers given by Almetyevsk (Russia, the Republic of Tatarstan) to the UNECE questionnaire.

<sup>101</sup> Based on the answers given by Tyumen (Russia) to the UNECE questionnaire.

<sup>102</sup> Glonass is a Russian equivalent to Galileo (Europe) and GPS (United States) satellite positioning systems

<sup>103</sup> Based on the answers given by Almetyevsk (Russia, the Republic of Tatarstan) to the UNECE questionnaire.



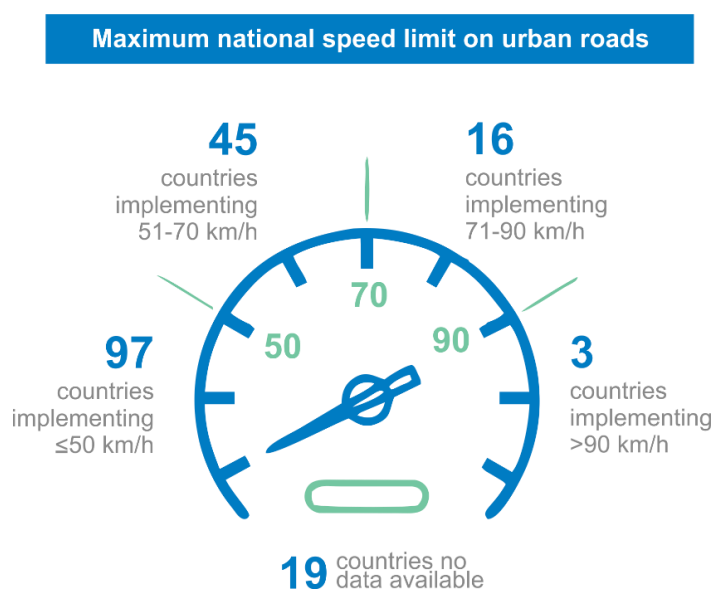
## 4.4 Safe city approaches for people centered cities

Around 1.25 million people are killed in road accidents all over the world with between 20 million and 50 million people suffering non-lethal injuries, many of which lead to disabilities. Road accident victims, their families and countries in general suffer significant economic losses. These losses come down to treatment costs, as well as lost productivity of those who have died or been left disabled following injuries as well as their families who need their time free from work or studies to tend to their relatives who have suffered injuries.

On average, road accidents cost countries 3 to 5% of GDP. 90% of road deaths occur in low- and middle-income countries despite them accounting for only about 54% of all motor vehicles in the world. Almost half of the world's road deaths happen among “vulnerable road users” i.e. pedestrians, cyclists and motorcyclists. Road accidents remain the leading cause of death of young people aged 15-29 years. Studies show that 40-50% of drivers exceed the maximum speed limit. Male drivers, young people and people driving under the influence of alcohol are more likely to be involved in high-speed road accidents. If no consistent countermeasures are taken, road accidents are projected to be the seventh primary cause of death by 2030.

Motorists often protest against speed limit reductions for fear that “traffic in the cities will grind to a halt.” In reality, however, this is not the case. The higher the speed of cars, the greater the distance between them, so fast driving is no guarantee of high-capacity streets. On the contrary: it is believed that optimum capacity in urban environments can be achieved at speeds of 50 to 65 km/h. With the speed limit down to 30 km/h, travel time goes up by a few minutes only. Quiet streets are quieter and more convenient for the elderly and children, which obviates the need for a certain number of car trips.

There is no doubt that high speed cuts down the travel time of drivers and passengers, and yet it often happens to be the source of a large number of road safety risks. Nonetheless, many countries still prioritise traffic speed of movement over safety. Statistics on speed limitation in different countries are shown in Figure 5.11, which illustrates the need for speed control measures.



### Illustration. Urban Speed Laws<sup>104</sup>

While the number of road accidents is on the decline, 26,000 people a year are still killed on the road in Europe, 38% of them in cities. Pedestrians and cyclists are at the highest risk. Roads are 8 times more dangerous than other settings<sup>105</sup>.

The safety of people in the city may be affected by a combination of various factors, but the speed of vehicles is the biggest one of them.

<sup>104</sup> <http://www.sum4all.org/publications/global-mobility-report-2017>, The Global Mobility Report, 2017: Tracking Sector Performance. Washington DC., Creative Commons Attribution.

<sup>105</sup> From a presentation of Anthony D. May, Professor of Transport Engineering, University of Leeds, UK.

Cyclists dislike riding among cars while pedestrians are stressed out by cyclists riding near them and so on. Everyone should have their own space: roads for cars, cycling paths for bicycles, dedicated lanes for public transport and sidewalks for pedestrians.

The wider the car lanes, the more difficult it is to stay within the speed limit as even responsible drivers are tempted to the urge to step on the gas while driving along a wide road. Narrowing lanes narrow can boost the safety of streets, keep drivers abiding by the law to a greater extent as well as leaving room for cycling paths, public transport lanes and sidewalks.

The targets of two SDGs relate directly to road safety. SDG 3 - to ensure healthy lives and promote well-being for all at all ages - includes a target to halve global deaths and injuries from road traffic accidents by 2020. SDG 11, which seeks to make cities inclusive, safe, resilient, and sustainable, incorporates a “Safe System” approach by focusing on access to safe, affordable, accessible, and sustainable transport systems and improving road safety by creating more public transport systems for all by 2030.

The “Safe System” approach to road safety is the best and fastest way to reduce traffic fatalities. Its widespread application will be necessary to meet the SDG target of halving the number of global road deaths by 2030. Beyond saving lives, the approach yields many other benefits, including economic, health, and environmental improvements. A “Safe System” for all road users addresses wider land use and mobility patterns in addition to design, enforcement, education, vehicle safety, and emergency response.

The “Safe System” approach requires a shift in responsibility from the people using roads to the people designing them. It is a systemic approach that integrates core management elements and action areas to create a safe mobility system.

The leading improvements in the “City for People” come down to ensuring safety for all road users (pedestrians, cyclists and motorists). The disastrous frequency of people dying often boils down to the geometry of streets that provokes high speeds, crossings put in place improperly, and scarce and dangerous cycling paths. Such places cannot be fixed altogether, but they need to be made safer given the concerns listed above.

The key to real change in road safety is shifting responsibility from people who use the road to people who design, set policy, execute operations, and otherwise contribute to the mobility system. An overemphasis on victim behavior and personal responsibility has long relieved pressure on governments to take responsibility and act to protect their citizens. This mindset needs to change, in terms of both public expectation and political and professional perceptions of responsibility<sup>106</sup>.

In improving road safety for pedestrians and cyclists, one of the most efficient means is improving the quality of infrastructure. The safety of different modes of transport is at its best when each mode has its own allocated route. Many Finnish cities have planned and started to implement a quality corridor network for cycling. Its purpose is to act as a fast lane for commuter cyclists moving between areas. This means improving existing routes but also building many new cycling paths. In addition to these quality corridors, Finnish cities have also put effort into improving the cycling conditions in centres. In these areas, the purpose is to integrate cyclists and pedestrians into the general flow of traffic when speeds are moderate (under 30 km/h). In busier routes, the target is to build cycling paths or as a minimum bicycle lanes.

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<sup>106</sup> <http://pubdocs.worldbank.org/en/912871516999678053/Report-Safe-Systems-final.pdf>, Sustainable & Safe: A Vision and Guidance for Zero Road Deaths, World Resources Institute, Washington, 2018

**Table. Principles, core elements, and action areas of the “Safe System” approach<sup>107</sup>**

PRINCIPLES	CORE ELEMENTS	ACTION AREAS	
Humans Make Errors	Economic Analysis J	Land Use Planning	Street Design and Engineering
Humans Are Vulnerable to Injury	Priorities and Planning	Improved Mobility Options	Speed Management
Responsibility Is Shared	Monitoring and Evaluation	Enforcement Laws and Regulation	Education and Capacity Building
No Death or Serious Injury is Acceptable	Comprehensive Governance and Management	Vehicle Design and Technology	Post-crash Emergency Response and Care
Proactive vs. Reactive	Strong Targets and Data		

**Case study. The new Road and traffic act in Finland.**

The purpose of the new Road Traffic Act adopted in Finland is to improve road safety. The obligation to anticipate and to behave cautiously in traffic will be laid down in acts and no longer in decrees. This will improve the position of vulnerable road users.

Government resolution on improving road safety sets a long-term vision that no one would be killed or seriously injured on the road. National strategy for walking and cycling 2020 aims that walking and cycling have their own positions in the transport system recognised alongside other modes of transport. Key measures to improve traffic safety include tighter speed control of motor vehicles, safe traffic arrangements particularly at junctions and crossings and the use of reflectors and helmets.

The new road traffic act, which will enter into force 2020 e.g. clarifies the use of road markings for cyclist crossing, offers new ways to promote cycling such as cycle street and possibility for contra-flow cycling on one way streets. The national guidelines for planning the pedestrian and bicycle traffic will be maintained by The Finnish Transport Agency. They include the systematic lowering of speed limits in housing areas to 30 km/h and promote different measures to improve pedestrian safety (e.g. new pedestrian crossings, elevated pedestrian crossings, improved lighting), as well as the use of structurally separated bicycle lanes when possible (city of Tampere)<sup>108</sup>.

**Case study. The vision zero policy in Sweden**

While Vision Zero has been delivered by reducing a number of on-the-road kills and major injuries, the results have not been positive for all groups of road users as for motorists.<sup>109</sup>

Vulnerable road users, such as pedestrians, cyclists and drivers of two-wheeled motor vehicles are particularly at risk. There is a potential to improve safety for cyclists through the use of good equipment, such as tires, brakes, lights as well as helmets. Currently the government of Sweden is drafting a national strategy for increased and safe cycling.

A number of factors and measures have indirect impact on transport safety. For example, traffic volume and composition is affected by traffic regulations, the economy, demographic trends and weather conditions. For example, studies conducted by the government of Sweden

<sup>107</sup> <http://pubdocs.worldbank.org/en/912871516999678053/Report-Safe-Systems-final.pdf>, Sustainable & Safe: A Vision and Guidance for Zero Road Deaths, World Resources Institute, Washington, 2018

<sup>108</sup> According to Finland's response to the UNECE questionnaire.

<sup>109</sup> The government of Sweden runs the Transport Agency's Traffic Accident Data Acquisition system to ensure good accident and incident reporting takes place because it creates the conditions for taking effective actions that improve road safety. The main feature of the system is that it collects data from both the Swedish Police and hospitals. According to the Green Mobility initiative, supported between 2013-2017 by the Nordic Council of Ministers (Copenhagen) which is being carried into effect by ICSEER Leontief Centre (based in St.-Petersburg), [www.mobility.leontief-centre.ru](http://www.mobility.leontief-centre.ru).



illustrate that a strong connection to the labor market, that is education, employment and income implies a lower risk of a road traffic accident. Likewise, a strong connection to family is related to longer distances travelled in road traffic environments, but also less likelihood of being involved in an accident.

Vision Zero calls for roads to be designed so that accidents do not lead to serious or fatal injuries. Examples of measures in the road design that have contributed to reducing serious and fatal injuries for pedestrians and cyclists include adaptation of speed limits and establishment of traffic calming measures such as roundabouts, speed humps and three lane roads.



## **Chapter 5.**

# **Reaping out the benefits of societal changes and energy transitioning**

## Chapter 5. Reaping out the benefits of societal changes and energy transitioning

### 5.1 Managing systemic transitions

#### 5.1.1 Empowering local governments

The UNECE region covers more than 47 million square km and is home to 17% of the world population, that is over 1,3 billion people as of 2019. It includes some of the world's richest countries, as well as countries with a relatively low level of development. This diversity in the levels of development represents *“a challenge to UNECE, as it must respond to the expectations of its different members. However, it is also an advantage, as it encourages the sharing of experience and knowledge, as well as a guarantee of financial and technical aid to countries in need.”*<sup>110</sup>

However, all regions, all countries, all cities, all stakeholders, are confronted to converging challenges and in particular, societal changes and energy transitioning. Across the globe, the civil society is showing signs of great awareness regarding environmental preservation and the promotion of healthier and more livable urban environments.



**Illustration: Thousands of Madrid citizens protest against the suspension of the “Madrid Central” anti-pollution plan introduced by Madrid new municipal government. Photo: Reuters, June 20 2019**

#### 5.1.2 Managing multiple transitions

The transition is about environmental and societal changes

Aspirations for healthier lifestyles and healthier livelihoods are growing. The notion of happiness used to be the cornerstone of development policies in the aftermath of World War II. It is back again, only that it is not promoted by governments, but by the people and especially the younger generations. In the next two decades, urbanization will continue to grow. In the absence of universally tested solutions to tame down quickly car and combustion engine dependency, the shift towards pedestrian, cycling, in other words active mobility oriented urban development models will go with frictions and tensions. It is not just a question of changing the modal split. Promoting

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<sup>110</sup> Source: UNECE



sustainable urban mobility requires committed but also well trained and skillful political leadership, as well as an effective engagement from within the civil society and the business sector. The sheer complexity and the costs of the on-going multifold transition cannot be underestimated.

The transition is about energy and industry

From every corner of the UNECE regions, we are witnessing rising concerns about GHG emissions and dependency on car, internal combustion engines, and fossil fuels. Yet, despite countless local initiatives, urban mobility -in particular when including logistics- still massively relies on fossil fuel and transitioning to other modes can be economically and socially very challenging. Cities can be a role-model but long-term gains will come from shared benefits. What would the point of developing zero CO2 urban cores if this meant longer commuting times and more urban sprawl for many?



**Table. Urban transport modal split in the world. A comparison**

Source: Roland Berger / *The Economist*, May 2019

### The exemplary case study of EV buses in China

The case of electrification of public bus and taxi fleets in China best exemplifies the interconnection between industry shifts and sustainable mobility. It is also exemplary of how globally public transportation is being shaped.

Since the end of 2018, reports and articles are piling up about an interesting and unanticipated phenomenon, which is questioning the whole mobility approach globally.

In May 2019, a report went so far so as to declare that “*The bus wars are over. Electricity – and China – won*”, comparing the 421,000 electric busses of China as of 2019 with the much smaller amount of 300 units in the US.<sup>111</sup> In reality, if electrics are now racing past a 50% share of new bus sales worldwide, according to Bloomberg New Energy Finance<sup>112</sup>, this is not only due to China. Across Europe as well as in Russia, for example, electric buses fleets are developing rapidly. Besides, other alternative sources of energy are also

emerging at a fast pace, such as hydrogen power vehicles.

The Chinese case, however, is striking. Out of a situation of serious congestion and air pollution in cities and especially the largest urban regions, subsidies and stringent pollution regulations have pushed more and more cities to switch over to electrics entirely. Shenzhen switch to all electric buses, in 2017 and the 13 million people metropolis now has 16,000 electric buses.

*The Guardian* reported in December 2018 that “*more than 30 Chinese cities have made plans to achieve 100% electrified public transit by 2020*” and the impact of such large changes is massive. Calculations show that the deployment of EV city buses in Chinese cities will help spare nearly 250,000 barrels of gasoline and diesel in 2019, according to Bloomberg New Energy Finance.

To stimulate demand, electric vehicles are strongly subsidized and exempt from purchase taxes. In six of the largest Chinese cities, they are also exempt from the restrictions placed on the purchase of cars with internal-combustion engines. The country’s charging infrastructure is rapidly developing, with Beijing having more public charging points than Germany, according to a research from *The Economist* from April 2019.

Together, these stimuli have created an electric-vehicle boom, so strong that some analysts say that sales of cars powered by internal-combustion engines in China have already peaked. According to McKinsey, China only lags two or three years behind America in autonomous driving but there is more, as China is creating a comprehensive ecosystem for mobility, including cars and

<sup>111</sup> Source: Think Progress. 2019. ThinkProgress is an editorially independent project of the Center for American Progress Action Fund

<sup>112</sup> Bloomberg NEF. *Electric Vehicle Outlook 2019*

other vehicles, apps, data, standards, communications... aiming to create new standards and deploy them globally.

The combination of *electrification* and *autonomy* is at the heart of the ongoing profound disruption which is taking place in China at a much faster pace than anywhere else. The tech sector is interested in batteries, in autonomous mobility, in artificial intelligence, in deploying 5G, and investors originating from the tech sector have also made large investments in bike sharing systems. According to *The Economist* whether such businesses can persist when their rental incomes fall far short of the capital costs remains unclear. *“If they can, it will be because of the value that tech firms capture from the data they provide. Providing the best advice on when to get on a bike, when to wait a minute for a bus and when to hail a Didi would bring with it an impressive flow of cash.”*

The interesting point about China is that public transportation is completely part of the game and is even partly driving it: the future mobility ecosystem connects tech companies, car and other motorized vehicle making companies, cities, governments...and transportation users.

In the case of China, the high proportion of internet users and the quasi-ubiquity of digital payment systems is driving a growing middle-class into rapidly changing behaviors. China is the world's largest market for rides ordered from a smart phone. The Didi ride hailing system has over 550 million registered users (which would correspond to nearly half of the total population of the whole UNECE region). According to *Roland Berger* consultancy, China might well be leading the way towards less car ownership not only in China, but globally. In 2017, car-sharing in China was ten times more developed than in the West, according to Roland Berger.

### The case of Poland's National Urban Policy

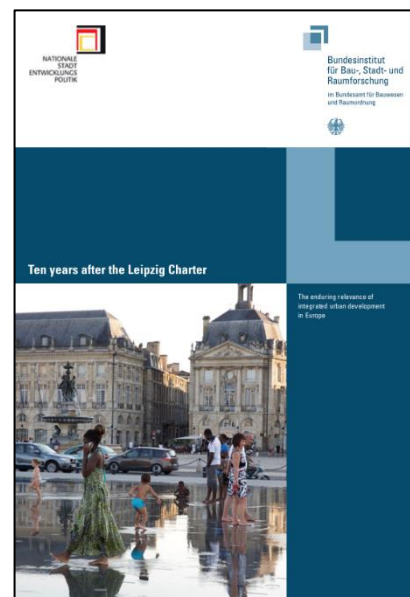
In the assessment of the 2007 Leipzig Charter on sustainable European cities that was conducted in 2017, the development and successful implementation of *“strategies to further the use of sustainable (and soft) mobility and intelligent city logistic systems”* is described as *“a major task for cities and city regions today”*. Improved connectivity is a leverage for sustainable urbanization not only from an environmental but also from a social standpoint as it helps bring together all parts of a given city.

Although there are already many EU initiatives and funding possibilities in this area, the report calls for *“more extensive coordination”* to maximize the results of these initiatives and to improve mutual learning. The objectives are to achieve *“sustainable and efficient urban mobility, focusing on public transport, reduction of motorized private transport and the promotion of so-called soft mobility (walking, cycling), accessibility (design of the public space for the disabled, elderly, young children, etc.), and efficient transport with good internal (local) and external (regional) connectivity.”*

A detailed assessment of the situation in the 28 EU member states shows very different situations.

Yet, if there can be no “one size fits all” approach to develop smarter and more sustainable mobility plans and strategies, the combination of regional approaches, local initiatives and national urban policies is an interesting way to build a coherent, low carbon, way forward in the field of mobility and transportation. This is illustrated, among others, by the case of Poland.

Poland's national-level policy is increasingly focused on actions aimed at cities in all their variety. In 2015, Poland created a National Urban Policy 2023 (NUP; *Krajowa Polityka Miejska*). This policy sets out the government's urban policy-related activities within the context of the 2017 national Strategy for Responsible Development (*Strategia na Rzecz Odpowiedzialnego Rozwoju*), the National Strategy of Regional Development 2010-2020: regions, cities, rural areas (*Krajowa*



*Strategia Rozwoju Regionalnego 2010-2020: region, miasta, obszary wiejskie*), and the National Spatial Development Concept 2030 (*Koncepcja Przestrzennego Zagospodarowania Kraju 2030*).

The Polish case exemplifies the rising global call for the creation and implementation of National Urban Policies as a strategic tool to frame urbanization and promote sustainability through city development.

In 2017, a global research in the 35 OECD countries concluded that while most OECD countries are actively engaged in developing and advancing at least some types of urban policies at the national level “*much work remains to be done to increase the scope of NUP and in making it an explicit strategy, such progress (being) a cornerstone for implementing the New Urban Agenda over the next 20 years as well as being crucial to the achievement of the SDGs and other global agreements such as those relating to climate change.*”<sup>113</sup>

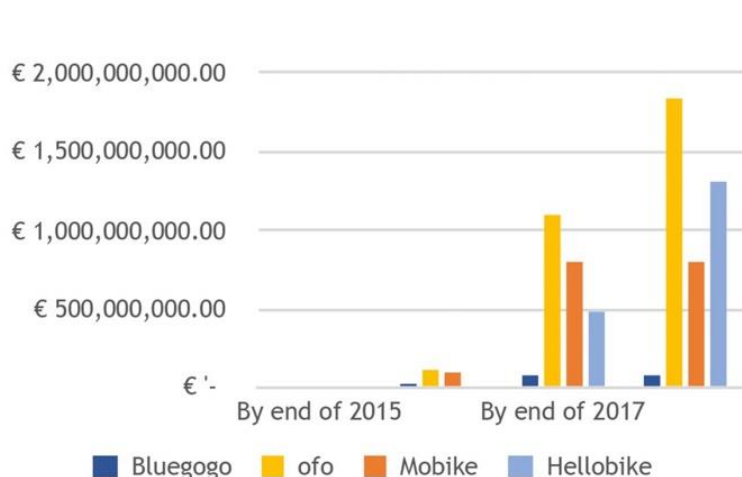
On-going initiatives such as the OECD working group on the territorialization of the SDGs are relevant ways to explore how to move from principles to implementation of multilevel urban governance and policies, including sustainable mobility as a priority area. Interestingly, after hosting COP24 in 2018, Katowice, in Poland, has been officially selected as the host city of the 2022 World Urban Forum in May 2019.

## 5.2 Environmental and societal changes impact on mobility behaviors: the sharing economy

### 5.2.1 The development of bicycle-sharing systems

As of 2016, there were more than 1.000 public bike-sharing systems operating in more than 50 countries around the world, up from 11 cities around the world in 2004<sup>114</sup>. The latest trend in bike-sharing is large scale free floating, a new market led by Asian companies which became global in less than five years although Germany, for example, introduced the concept of free floating bike-sharing in 2000. Bike-sharing is no longer a local or a municipal issue. It has become a global mobility and transit issue, notwithstanding complex environmental consequences.

**Figure. Total funding raised by selected free-floating bike-sharing companies (as of July 2018)<sup>115</sup>**



*Mobike*, a Hong-Kong based company which successfully started operation in nine major Chinese cities (Beijing, Shanghai, Shenzhen, Guangzhou...) in 2015 has then expanded to over 200 cities in 15 countries, with 200 million registered users, 9 million bikes in daily operation, and 30 million rides per day. Although the company, now a world leader, claims it has contributed to save that 4.4 million tonnes of CO<sub>2</sub> equivalent emissions of ridership of its bicycles, free floating bike

systems have developed very fast and the market is highly volatile. *Mobike*, for instance, was

<sup>113</sup> *National Urban Policy in OECD Countries*, OECD, 2017, 140p

<sup>114</sup> Rosamond Hutt, *Mapping of bike-sharing data will change the way you see these cities*, World Economic Forum, August 10, 2016, <https://www.weforum.org/agenda/2016/08/what-bike-share-data-can-tell-us-about-our-cities/>.

<sup>115</sup> Source of the graph and figures. *The evolution of free floating bike-sharing in China*. S. Ibold, dr C. Nedopil, In *Sustainable Transport in China*, August 2018



bought in 2018 by *Meituan*, a Chinese e-commerce company which is exploring ways to get it of its European subsidiary due to high deficits. By the end of 2017, about 16 million bikes “floated” on China’s streets to transport about 130 million registered users. The growth came to a sudden halt in 2017 with the bankruptcy of *Bluegogo*, the third largest operator, with many more following the same fate. Meanwhile, the rest of the world follows the roller-coaster fate of Chinese free floating bikes.

**Illustration. The introduction of the GoBike free-floating system in Almetьевsk in 2017 (Russia, Republic of Tatarstan)<sup>116</sup>**



Due to the colossal rate of development of free floating bikes, sustainability issues arose such as the clogging of public spaces and the massive destruction of bikes. In 2017, the UN Global Compact named Mobile a Un Environment champion of the Earth for entrepreneurial vision, sparking a global controversy.

Europe’s largest bicycle dealers cooperative, ZEG, a German company, renounced its membership of the Global Compact pointing out to the negative environmental consequences of massive quantities of aluminium required to produce massive quantities of cheap bikes without any recycling policy. Though the rapid development of biking allowed by free floating systems should have positive environmental impacts, such as reduced congestion, improved air quality, increased accessibility of public transit by complementing public transport services<sup>117</sup> this service cannot go without proper regulation and without transparent and accountable policies regarding bikes production and recycling.

The fact that free floating bike systems have become so widespread so quickly illustrates a demand for passenger transport that had thus far been largely unmet. This type of on-demand transportation is an example of how the Internet of Things (IoT) technology is changing transport. Such systems also collect large amounts of data on user patterns, which could potentially be used to analyse transit systems. The activity of these systems generates an enormous amount of data, on the order of tens of terabytes per day. As more and more people use dockless bike-sharing systems on a regular basis, these systems are becoming a fixture in the landscape of transit options, bringing more areas within range of public transit systems and therefore effectively increasing public transit ridership<sup>118</sup>.

Apart from free floating, docked bike-sharing systems have been developed the world-over in the last decade.

In China, the city of Hangzhou initiated a public station-based bike-sharing (PBS) scheme in 2008 for its 4.8 million inhabitants. The number of public bikes in the city grew from only 2,000 in 2008 to about 84,100 in 2016, with a total of 3,572 stations. In comparison, the biggest public bike-sharing scheme outside of China, *Vélib’* in Paris, operates a total of 1,751 stations and 23,900 bicycles.

<sup>116</sup> Based on the answers given by Almetьевsk (Russia, the Republic of Tatarstan) to the UNECE questionnaire.

<sup>117</sup> The Bike-share Planning Guide, ITDP, [https://www.itdp.org/wp-content/uploads/2014/07/ITDP\\_Bike\\_Share\\_Planning\\_Guide.pdf](https://www.itdp.org/wp-content/uploads/2014/07/ITDP_Bike_Share_Planning_Guide.pdf)

<sup>118</sup> [https://www.itf-oecd.org/sites/default/files/docs/policy-priorities-decarbonising-urban-passenger-transport\\_0.pdf](https://www.itf-oecd.org/sites/default/files/docs/policy-priorities-decarbonising-urban-passenger-transport_0.pdf), Policy priorities for decarbonizing urban passenger transport. OECD/ITF, 2018

Today, a lot of cities around the globe have their own bike-sharing systems, and more programs are starting every year. The largest systems are in China, in cities such as Hangzhou and Shanghai. In Paris, London, and Washington, D.C., highly successful systems have helped to promote cycling as a viable and valued transport option. Each city has made bike-share its own, adapting it to the local context, including the city's density, topography, weather, infrastructure, and culture. Although other cities' examples can serve as useful guides, there is no single model of bike-share.



**Illustration. The city mayor of Paris and the president of Paris metropolitan authority in a show to publicize the new Velib' bikes in 2018<sup>119</sup>**

**Case study. The Gdańsk - Gdynia - Sopot Metropolitan Area bike sharing system in Poland<sup>120</sup>:**

The system, called MEVO, launched as a single public bike sharing scheme in the 14 cities and communes of the Gdańsk - Gdynia - Sopot Metropolitan Area in Pomeranian Voivodeship, Poland. The electric bike can be used by residents and tourists visiting Gdańsk, Gdynia, Sopot, Tczew, Puck, Reda, Kartuzy, Sierakowice, Somonino, Stężyca, Władysławowo, Żukowo, Pruszcz Gdański and Rumia.

The bikes can be collected from any of 660 bicycle stations spread across 6 cities and municipalities in the Metropolitan Area. Renting and returning bicycles to any of these stations is at no extra charge. Bicycles can also be returned outside the designated parking stations; for an additional fee of PLN 3, bicycles can be returned anywhere within the area of use (the boundaries of individual cities), as long as they are left in a public place and do not hinder other users of public space.

Cyclists that rent a bicycle from any location outside the 660 stations and who return it back to one of the stations, earn a bonus in the form of a 2 Zlotys (0.47 euro) top-up. Rental fee without subscription is 0.10 Zloty per minute. Monthly subscription and annual subscriptions are also available at respectively 10 Zlotys (per month) and 100 Zlotys (per year). Subscribers are able to use a bicycle for 90 minutes per day and pay a fee of 0.05 Zloty per minute once the 90 minutes have been exceeded. MEVO is one of the first bicycle systems in Poland available all year round. Starting with 1,224 bicycles, it is planned that the number of bicycles in the Gdańsk - Gdynia - Sopot Metropolitan Area will ultimately be increased to 4,080. During the winter season, part of the fleet will be kept in storage, as demand will be lower. The project is co-financed by the European Regional Development Fund under the Regional Operational Program of the Pomeranian Voivodeship for the years 2014-2020.

<sup>119</sup> Source, paris.fr, Jan. 2018 After it was introduced, the deployment of the new Paris bike sharing system faces many drawbacks including months long delays to create new docking stations and problems with the new bikes, quoted as expensive and fragile.

<sup>120</sup> <http://www.eltis.org/discover/news/one-eus-largest-electric-bike-sharing-systems-launched-gdansk-gdynia-sopot>, Michiel Modijefsky, 2019.





**Illustration. Mevo bike sharing system (one of EU's largest electric bike-sharing systems) launched in Gdańsk - Gdynia - Sopot Metropolitan Area (Poland)<sup>121</sup>**



The development of bike-sharing systems can also include several types of bikes, including cargo-bikes, as currently experienced in the new mixed use development project of Aspern near Vienna in Austria.

**Illustration: Cargo e-bike sharing system in Aspern. Source: Renaissance Urbaine, 2016**

Successful bike-sharing systems across the globe share common features:

- A dense network of stations across the coverage area, with an average spacing of 300 meters between stations;
  - Comfortable, commuter-style bicycles with specially designed parts and sizes that discourage theft and resale;
  - A fully automated locking system that allows users to check bicycles easily in or out of bike-share stations;
  - A wireless tracking system, such as radio-frequency identification devices (RFIDs), that locates where a bicycle is picked up and returned and identifies the user;
- Real-time monitoring of station occupancy rates through wireless communications, such as general packet radio service (GPRS);
  - Real-time user information through various platforms, including the web, mobile phones and/or on-site terminals;
  - Pricing structures that incentivize short trips helping to maximize the number of trips per bicycle per day.

### **Case study. More cycling through shared e-bike systems in London<sup>122</sup>:**

Shared e-bikes, implemented at scale, could double the number of bicycle trips in London, increasing their modal share and reducing congestion and pollution. A recent report by Steer suggests that 813 000 daily trips in Greater London could switch to shared e-bikes. This would lead to 21 000 fewer hours spent in traffic and 184 fewer metric tons of CO<sub>2</sub> emissions every

<sup>121</sup> More information: Mevo bike sharing system: <https://rowermevo.pl/en/>.

<sup>122</sup> <http://www.eltis.org/discover/news/cycling-could-double-london-shared-e-bike-systems>, Michiel Modijefsky, 2018.



day. Based on current trip patterns, the study assessed how many daily trips could potentially switch to shared e-bikes. The study uses a 'switchable trips' methodology that is also applied in Transport for London's (TfL) – Analysis of Cycling Potential. It considers both complete (door-to-door) trips as well as the first/last mile station access/egress portion of public transport trips. However, it excludes trips by children, people over 80 years of age, and trips that are too long, too short, or that involve accompanying children or carrying luggage.

On this basis, the study finds that out of the 17.4 million daily trips made across Greater London, about 8.2 million trips are potentially 'switchable' to shared e-bikes. It is suggested that large-scale deployment of e-bikes would result in a switch of 813 000 daily trips to shared e-bikes. This corresponds to a modal share of 4.7 %, roughly twice the current share. The largest part of the modal shift to e-bikes comes from public transport (325 000 trips), followed by vehicles (279,000 trips), while changes in walking (116 000 trips) and first/last mile (95 000 trips), trips account for the remainder of the modal shift.

An important assumption underlying the calculations in the report is that the positive trend in cycling use seen in recent years continuous. London Mayor's Transport Strategy aims to ensure that by 2041, 80% of journeys in London will be made by cycling, walking and public transport. To reach this objective continued investment cycle infrastructure is required which normalises cycling for a wider range of people and for more trips. The introduction of shared bike schemes has been a strong force in popularising cycling. The Steer report estimates that development of a shared "dockless" e-bike system(s) at scale would require between 81,000 to 163,000 new e-bikes in London, along with the necessary bike lane and charging infrastructure, to meet the identified demand.

In order to ensure the benefits of such schemes are maximised – and that London avoids the problems they have caused in other cities – a strategic approach is required, a report by the London Assembly Transport Committee concluded earlier this year. The report calls the implementation of a London-wide licensing scheme involving a small number of operators being licensed to lend bikes across the city. In addition, Supplementary Planning Guidance for cycling should instruct boroughs to require that new developments have parking space for dockless bikes and TfL should provide space in appropriate places on the TfL Road Network.

Currently, TfL does not have the powers to regulate dockless bike operators at a London wide level as this falls within the remit of the local highway authorities. TfL is working with London Councils to explore the possibility of establishing a new bye-law to enable a pan-London approach to be taken. TfL is also considering the best approach to dockless parking as more bikes are deployed and, based on operational feedback from boroughs, is planning to update its code of practice for operators.

## 5.2.2 Car-sharing systems are now part of the urban mobility portfolio

Sharing economy an issue popularized a decade ago, is a game changer in the field of mobility<sup>123</sup>, based on the collective use of goods and services, barter and lease instead of ownership. PwC estimated that in 2015 (no later studies have yet been conducted) there were over 300 companies operating in different sectors of the collaborative consumption economy in Europe. Various online platforms in this field are expected to generate a world market with a volume of up to 335 billion USD by 2025.

In less than a decade, transport services have become a major sector for collaborative consumption. Owning a personal vehicle is growing increasingly burdensome for people: firstly, the value of the car drops considerably once it is put to use, which does not make this purchase an effective investment; secondly, current operating conditions for cars in cities serve to render them more difficult, inefficient and costly for the owner.

By contrast, users moving away from car ownership by switching to car sharing services can bring about major social effects such as growing well-being of the population achieved through

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<sup>123</sup> *What's Mine Is Yours: The Rise of Collaborative Consumption*. Rachel Botsman and Roo Rogers, 2010

saving on car purchase; reducing the space taken up by parked cars; lower consumption of resources used for the manufacture of cars and their components, less waste associated with the operation and scrapping of vehicles, reduced pollutant emissions (by transport companies relying on environmentally friendly vehicles and by cutting down the excess mileage of vehicles in search of parking spaces).

As applied to the transport system, shared use mechanisms are represented by ride-hailing (Uber, Gett, Yandex, etc.), short-term car rental (car sharing), fellow travellers search (car-pooling or ridesharing) although in practice, the generic term of car sharing is widely acknowledged to designate individual and platform-based car sharing. The commonplace application of such services has become a reality thanks to the following technological advances:

- GPS devices used to determine the driver route and organise a shared trip;
- Smartphones that enable users of a service to request for a trip regardless of the location;
- Social networks that make the service transparent while also bolstering the level of driver - passenger trust.

In 2014, car sharing had almost as many as 5.000.000 users worldwide, up from 350.000 in 2006, and the number of users is projected to exceed 23.000.000 worldwide by 2024 year<sup>124</sup>.

There are two car-sharing models in the world depending on who owns the fleet:

- B2C (business-to-customer) - a company purchases cars for subsequent rent. This model is operated, for example, by Zipcar, StattAuto and GoGet;
- P2P (peer-to-peer) - a company rents private cars from owners who seek to earn extra money on their cars which they are not currently using with the company renting the vehicles to customers. This is the way RelayRides, Whipcar, Wheelz and GetAround are run.

Implementing car sharing models can create negative effects. Congestion is a challenge for car sharing operators as it makes planning and managing the fleet more difficult preventing users from returning cars to the parking lot in time. In order to offset this imbalance to some extent, operators in congested cities often deploy a large fleet of vehicles thereby being able to meet users' orders even during congestion. This certainly results in excess expenditures and cars standing idle in between the rush-hours. In addition, traffic jams make it difficult for customers to plan their expenses as some companies charge penalties for delays in returning cars. Mindful of this, some operators offer users rates with flexible time intervals for car return or special conditions of reimbursement for unused hours.

To develop car sharing, experts recommend that operators should be exempt from a number of restrictions that apply to drivers of private cars, and in some cases, they should be given certain privileges: exemption from parking fees and entry fees to the city centre, and access to designated lanes in exceptional cases.

The primary legal barriers to the development of car sharing imposed by legislation are related to establishing the legality of this type of activity, because, much like in the other examples of sharing economy, issues associated with defining the responsibilities of parties, exercising control over the activities of users, economic transparency and many others are inherent in the car sharing. Furthermore, car sharing operators entering new markets are often faced with fierce competition from similar modes of transport, such as taxis and conventional car rental.

Usual problems that still need to be addressed by car sharing systems are the potentially poor condition of the car, as some customers tend to take less care of car sharing cars than others so the fleet inevitably deteriorates in appearance, both externally and internally and the lack of

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<sup>124</sup> Navigant Research, Global carsharing services revenue is expected to reach \$6.5 billion in 2024, <https://www.navigantresearch.com/newsroom/global-carsharing-services-revenue-isexpected-to-reach-6-5-billion-in-2024>.

cars in crowded points of attraction. For example, finding a free car in the city centre can prove extremely hard during rush hours in the morning and evening on weekdays with people in a rush to get to work or home. Last for not least, there is no unified way to measure car sharing across the globe, making it quite difficult to conduct precise comprehensive assessments apart from analysing case studies.

**Illustration Car sharing business models<sup>125</sup> and aglobal mapping of B2C car sharing platforms in the world in 2015/2016<sup>126</sup>**

	Traditionalists	Citizen networkers	Mobility integrators	Innovative OEMs
Unique Selling Proposition	<ul style="list-style-type: none"> <li>Mainly low-cost cars</li> <li>Full service model</li> <li>Broad range of vehicle types</li> </ul>	<ul style="list-style-type: none"> <li>"Virtual" fleet made up of vehicles from participating owners</li> <li>Usually large selection of cars</li> </ul>	<ul style="list-style-type: none"> <li>PTOs enlarging their service portfolio in order to offer door-to-door mobility</li> <li>Strong PTO brand</li> </ul>	<ul style="list-style-type: none"> <li>Premium cars also</li> <li>User communities</li> <li>Value add location based services</li> <li>Strong OEM brand</li> </ul>
Advantages	<ul style="list-style-type: none"> <li>Lower usage fees</li> <li>Booking possible without smartphone usage skills</li> <li>-&gt;Appropriate for older customer groups</li> </ul>	<ul style="list-style-type: none"> <li>Insurance included</li> <li>Cheaper compared to car sharing/rental</li> <li>Suitable for less density populated areas</li> </ul>	<ul style="list-style-type: none"> <li>Leveraging existing customer base</li> <li>Integration into own intermodal apps (e.g. Qixxit) and mobility cards (e.g. BahnCard)</li> </ul>	<ul style="list-style-type: none"> <li>Mainly free floating<sup>1</sup></li> <li>-&gt; spontaneous hire</li> <li>Intermodal apps (e.g. moovel)</li> <li>Usually minute based charging</li> </ul>
Disadvantages	<ul style="list-style-type: none"> <li>Mainly station based services</li> <li>-&gt;Less flexibility</li> <li>Sometimes complicated processes for customers</li> </ul>	<ul style="list-style-type: none"> <li>Critical mass decisive</li> <li>Car theft issues</li> <li>Neighborhood based geographic scope</li> <li>No full service model</li> </ul>	<ul style="list-style-type: none"> <li>Mainly station based services</li> <li>-&gt; Less flexibility</li> <li>Sometimes complicated processes for customers</li> </ul>	<ul style="list-style-type: none"> <li>Higher usage fees</li> <li>Smartphone usage skills needed</li> <li>Booking in advance (&gt; 30 minutes before) not possible</li> </ul>
Examples	<ul style="list-style-type: none"> <li>Greenwheels/StattAuto</li> <li>StadtMobil</li> <li>Communauto</li> </ul>	<ul style="list-style-type: none"> <li>Tamyca</li> <li>Jolly Wheels</li> <li>RelayRides</li> <li>Getaround</li> </ul>	<ul style="list-style-type: none"> <li>Deutsche Bahn - Flinkster</li> <li>Veolia Transdev - Autobleue</li> <li>Keolis - Autocool, Lilas, Auto'Tao, IDElib'</li> </ul>	<ul style="list-style-type: none"> <li>BMWDriveNow</li> <li>Daimler car2go</li> <li>Volkswagen Quicar</li> <li>Citroen Multicity</li> </ul>



<sup>125</sup> [https://www.uitp.org/sites/default/files/members/140124%20Arthur%20D.%20Little%20&%20UITP\\_Future%20of%20Urban%20Mobility%202%200\\_Full%20study.pdf](https://www.uitp.org/sites/default/files/members/140124%20Arthur%20D.%20Little%20&%20UITP_Future%20of%20Urban%20Mobility%202%200_Full%20study.pdf), Arthur D. Little and International Association of Public Transport (UITP), The Future of Urban Mobility 2.0, 2014.

<sup>126</sup> Source: TSRC Shaheen 2015, ACEA 2014, 6t) bureau de recherché 2013, German Car Sharing association 2015, Boston Consulting Group, 2016. In ADEME, *Enquête nationale sur l'autopartage. Edition 2016, état des lieux technique et méthodologique.*





**Case study. The Autolib' experience in Paris and Paris metro area: a complex public-private organisation<sup>127</sup>**

Paris municipal government launched “Autolib” a city-wide and then metro-wide electric car sharing system in 2011. As of 2017, the service used over 3,900 vehicles and 1,100 charging stations in Paris and surrounding municipalities. A dedicated legal entity, *Syndicat Mixte Autolib'* was formed in 2008/9 to oversee the development of car-sharing public service. Autolib', a dedicated private company and a subsidiary of Bolloré group, a multinational French company, started to operate the system after winning a public tender in 2008, in principle at no cost for municipal finance. Although Autolib' was a kind of success with more than 300,000 rentals/month, the system was never profitable with a total debt of nearly 300 million euros, according to the operator. In 2016, *Syndicat Mixte Autolib'* was merged with the entity managing the municipal and metropolitan bike sharing system *Velib'*, forming a new entity known as *Syndicat Autolib' et Velib' Métropole*. Yet in 2018, the bankrupt

Autolib' had to stop operation in the midst of a controversy between Bolloré Group and *Syndicat Autolib' et Velib' Métropole*. The service met many problems during a short decade of operation. Cars and stations often served as shelters for homeless people, while also stirring discontent about an overuse of public space in the centre of Paris. Several companies such as Moov'in Paris (Renault), Free2Move (PSA group), Car2go (Daimler group) are now using the electric charging points of the former Autolib' system.

**Case study. The car sharing in Moscow (Russian Federation)**

Car sharing was launched in Moscow in 2015 preceded by the city bike rental system starting in 2013 and followed by electric scooters rental opening up in 2018. Now the car sharing network in Moscow encompasses 11.000 cars whereas the bike rental network boasts 4.300 bicycles stationed at 430 locations and 2.950 electric scooters. The number of users rises with every year. Currently, there are more than 30.000 car sharing trips and over 27.000 bicycle trips per day in Moscow.



In early autumn, 2018, there were 15 car sharing operators registered in Moscow; all of them offering different car makes, prices and parking areas. While most of them are only available within the Third Ring Road, there are also services that cover remote areas and enable users to get to or from the airport by car.

In Moscow, companies that provide car sharing services need to comply with several conditions designed by the Moscow Transport Department:

- round-the-clock operation;
- cars not older than 3 years;

<sup>127</sup> Illustration source: L'Express.fr / [vivrelemarais.typepad.fr](http://vivrelemarais.typepad.fr)

- environmental status of Euro - 4 or higher;
- cars must be marked with the logo “Moscow Carsharing” on a compulsory basis;
- availability of a GLONASS satellite system in and remote access to cars.

However, each operator has different coverage areas. The contract offered by each company specifies in clear terms the conditions for concluding that contract. Often this is the minimum age and seniority of the driver<sup>128</sup>.

### 5.2.3 Carpooling and ridesharing

Car-pooling and ride sharing, a C-to-C (consumer to consumer) way of car sharing have also followed an accelerated development in the last decade, linked with the use of smart phone and web based tools to connect users. Although car-pooling mainly depends on private initiative, this is becoming an integrated part of multi-mode mobility strategies. In France rural and periurban areas for instance, the development of dedicated car-pooling parking is being pushed by local, district and regional governments altogether, as illustrated below.

The first carpooling projects emerged in the 1990s and initially met many obstacles such as the need to build up a user community and a convenient way of interaction with each other. This kind of service has proven particularly attractive in areas poorly covered by public transport.<sup>129</sup> Also, carpooling is more popular among those who travel in the same direction every day (by 30%) than those who travel on casual trips.

The following types of carpooling are distinguished depending on the method of planning a joint trip:

- Classic: usually a long (from 100 km) trip, planned in advance (from 1 day to several months);
- Dynamic: travelling over short distances in urban space (1 — 100 km) with alternatives available (by own car, public transport, taxi, bicycle or on foot);
- Regular: the users, the route and the schedule of the trip are constant.

**Table. Typical car-pooling benefits and weaknesses**

Typical carpooling benefits	Typical carpooling weaknesses
<ul style="list-style-type: none"> <li>• Savings on fuel, repair, parking and fees;</li> <li>• Reduced traffic congestion thanks to car enthusiasts and fellow traveller riding together in one car;</li> <li>• Reduction of emissions of pollutants and climate gases;</li> <li>• Avoiding stress and driving load. Taking turns day-by-day allows carpooling users to alternate in driving;</li> <li>• Shared rides help to make new acquaintances. With modern society focused on individualism and independence of everyone, such an opportunity can prove of high value.</li> </ul>	<ul style="list-style-type: none"> <li>• The driver is responsible for the delay should his/her car vehicle involved in a car accident;</li> <li>• Drivers sometimes have to come and pick up their passengers which extends their travel time;</li> <li>• It is hard for municipal authorities to organize and support the operation of carpooling;</li> <li>• Risk of riding with a fellow traveller with criminal intent.</li> </ul>

<sup>128</sup> <http://voditeliauto.ru/poleznaya-informaciya/online/carsharing.html> as well as based on the answers given by Moscow (Russia) to the UNECE questionnaire.

<sup>129</sup> Elizabeth Deakin, Karen Trapenberg Frick, Kevin Shively. Dynamic Ridesharing // Access. — 2012. — № 40. — C. 23—28. A study conducted at the University of California Berkeley in 2010 showed that about 20 percent of respondents are willing to do ridesharing at least once a week



Illustration. The official inauguration of car-pooling parkings in Manosque and Peyruis (Haute Provence, France)<sup>130</sup>

### 5.3 The energy transition: urban mobility without fossil fuel?

The challenge of enhancing the energy efficiency of motor vehicles is part of the overall goal pursued by the world community to save energy resources, reduce environmental pollution and avert severe climate change. According to the *International Organization of Motor Vehicle Manufacturers*, fossil fuel motorized vehicles only account for less than 20% of GHG in the world, making it a secondary issue. However, the number of vehicles in circulation is expected to double by 2050 as compared to the beginning of the century, especially in urban areas, already plagued by air pollution.

Transport accounts in average for more than 50% to local and regional air pollution with more accurate proportions depending on both the pollutant and location<sup>131</sup>. Life cycle assessment studies show that rail transport, including high - speed lines, and urban electric transport affect environment and public health to a considerably lesser degree.

EV technology (i.e. plug-in hybrid and battery EVs) presents a promising option for technological advancement in urban travel, offering the potential for efficiency improvements of up to 100% relative to ICE vehicles. Direct-charging electric battery vehicles, in particular, present the most attractive option long term, even compared to other zero-emission technologies.

The well-to-wheel (WTW) energy efficiency of direct-charging battery EVs is 73%, versus 22% and 13% for hydrogen fuel cell and power to liquid vehicles, respectively. Electric vehicles will also be increasingly attractive from a financial point of view, given that the price of electricity is expected to fall as new solar and wind energy sources become operational. Continued technological advancements are also reducing the price of EV batteries and increasing their range, both of which increase their appeal among potential buyers. Despite these favourable trends, public policies will need to be put in place in order to accelerate the adoption of EVs.

The way in which EVs complement other sustainability measures should also be taken into account when designing new technologies and solutions. EVs can, for example, contribute to the development of the smart grid by charging during off-peak hours, providing back-up power to the grid, and facilitating the incorporation of clean energy charging stations into grids and buildings.

The former strategy would reduce ownership costs for consumers, and the latter could include, for example, battery leasing schemes and OEM activities that would be profitable for

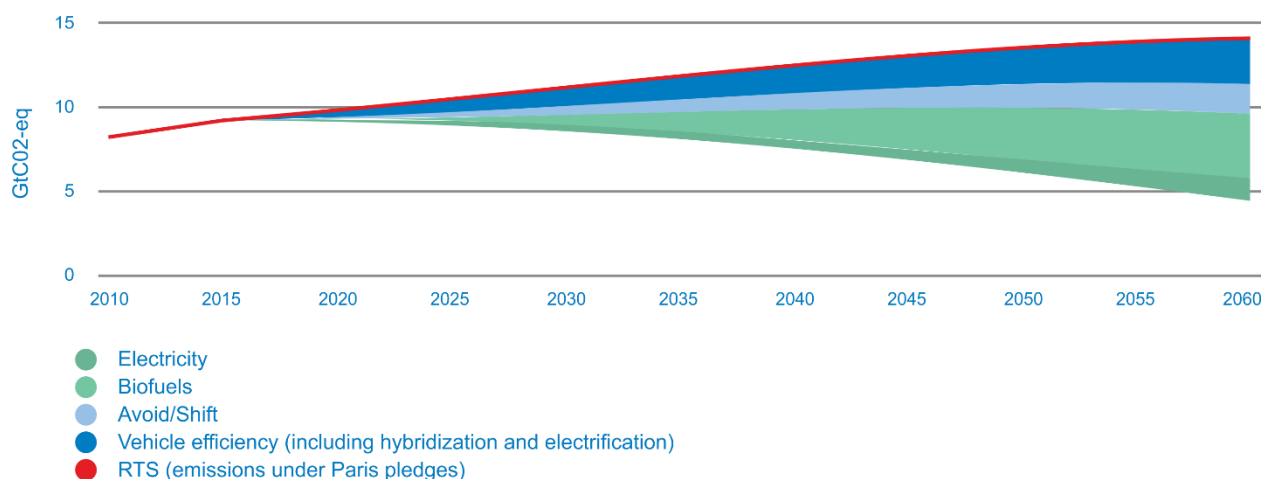
<sup>130</sup> Source: Haute Provence info, April 2013

<sup>131</sup> <http://eco-madi.ru>, Ecotransport: textbook / S.V. Shelmakov — M.: MADI, 2018.



businesses. Innovative solutions for advancing e-mobility will notably involve a wide range of stakeholders, including new technological actors, mobility operators, cities and public authorities, infrastructure developers, city planners, electricity utilities, after-sales and end-of-life actors, as well as NGOs. Ongoing issues that will need to be addressed in the continued development and rollout of EVs include designing battery leasing operations, reducing the lifecycle emissions of new e-mobility technologies (e.g. EV batteries), automating e-mobility options, and adapting EV designs for shared use<sup>132</sup>.

**Figure. The Well-to-wheel GHG emissions in the RTS and 2DS scenarios of ETP 2017, 2015-2060<sup>133</sup>**



### 5.3.1 The rapid growth of electric cars, a catalyst for cleaner mobility

The development of electric cars is major change in mobility trends. As for bikes and even to some extent trams, this is not a phenomenon specific to UNECE region but a global issue. 2016 was acknowledged as an excellent year for electric vehicles sales across the globe, whereas global sales of conventional cars saw an uptick of 5%. The growth of the passenger electric transport market was ahead of the traditional one by 10 times, and yet, its share still accounted for just 1% of the total car market<sup>134</sup>.

A 2018 study by the International Energy Agency shows that 2017 has been even better with a total of more than 3,000,000 electric and hybrid vehicles sold.<sup>135</sup> In the course of 2017, the number of these vehicles went up by 56% compared to 2016. IEA experts believe that state support coupled with lower battery production costs are the key reasons behind the record-breaking spike in the number of electric vehicles. The factors of further growth for the global fleet of electric vehicles are: development of EV charging infrastructure, ramping up the manufacture of batteries and stable supply of materials needed for their production.

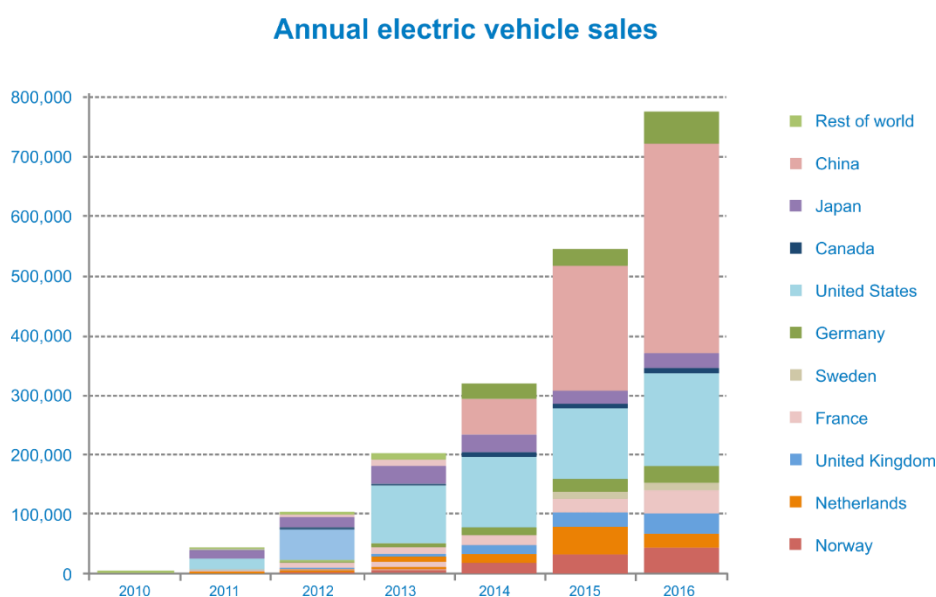
<sup>132</sup> [https://www.itf-oecd.org/sites/default/files/docs/policy-priorities-decarbonising-urban-passenger-transport\\_0.pdf](https://www.itf-oecd.org/sites/default/files/docs/policy-priorities-decarbonising-urban-passenger-transport_0.pdf), POLICY PRIORITIES FOR DECARBONISING URBAN PASSENGER TRANSPORT © OECD/ITF 2018

<sup>133</sup> <https://www.iea.org/topics/transport/>, International Energy Agency.

<sup>134</sup> <http://www.forbes.ru/biznes/338511-elektromobili-budushchee-uzhe-zdes>.

<sup>135</sup> <https://webstore.iea.org/global-ev-outlook-2018>, Global EV Outlook 2018, International Energy Agency, France, 2018.

Figure. The global rise of electric vehicle sales<sup>136</sup>



China is the leading market for EV sales: in 2017, 580,000 electric vehicles were sold in China which accounts for about half of the EV's sold around the world. Sales grew by 72% as compared to 2016. The United States has come in second with 280,000 in 2017 (up from 160,000 in 2016).

Within the UNECE region, Northern Europe is a hub for

electric transport development. The share of electric cars last year accounted for 39% of new cars sold in Norway, making the country the world leader in the market of electric cars according to this measure. Electric cars accounted for 12% of all car sales in Iceland, and 6% in Sweden. Among developed countries, Germany and Japan are also worth mentioning, as both countries witnessing a significant uptick in the EV fleet. Sales in Germany and Japan more than doubled in 2017 as compared with 2016.

**Illustration A prototype of electric car designed by Kalashnikov company unveiled in 2018 echoing the Izh-Combi Soviet model from the 1970's**



The image of EVs has been profoundly changing. Premium German car brands are being challenged by Tesla from the United States, at present the largest and by far the trendiest electric cars maker in the world. In parallel, several new companies have been created in the very past years in China. European car makers have started to build a response. Electric cars are definitely the new trend.

**Illustration. Electric charging station in rural areas (here in Sank Michaël in Lungau, Austria) are becoming commonplace throughout Europe**



Although the development of charging infrastructure may be a challenge in many cases, networks of charging stations keep advancing rapidly, covering not only cities but also non - urban road infrastructure.

The expected environmental outcomes of more electric cars on the roads are huge, although complete lifecycle assessments of electric vehicles as compared with fossil fuel vehicles need to be refined. According to *Eurelectric* association, an electric car would reject 66g of CO<sub>2</sub>/ km of mileage whereas a traditional car running on gasoline would reject 124 g. Promoters of electric vehicles point out to a number of other

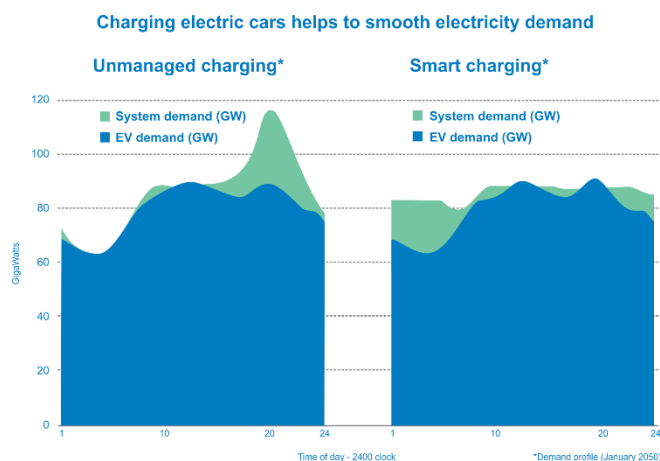
<sup>136</sup> Presentation by Michael P. Walsh, International Consultant, Founding Chairman Board of Directors, International Council on Clean Transportation, Moscow, Russia, May 19, 2017.

positive factors for the European economy linked with EV development, encouraging electric cars to become the new normal:<sup>137</sup>

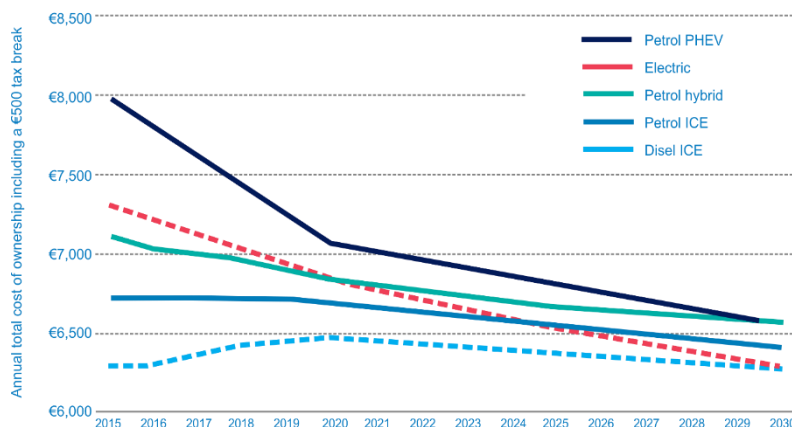
- Creation of 200,000 new jobs by 2030
- there are sufficient recharging points in western and northern Europe today for the early market & that just 5% of charging happens at public recharging points;
- Are lower CO2 today even when compared on a full life-cycle basis and even in countries with the least green electricity;
- Battery cells will be manufactured in the EU and there are sufficient raw materials available;
- Are affordable. With very modest tax breaks they are already cheaper on a total cost of ownership for the first owner. For second and third owners, there are substantial savings in running costs and maintenance.

**Figure. Impact of EV charging on power grid management**

Fears that charging of EVs will cause widespread blackouts are probably exaggerated but the widespread electrification of mobility will have lasting impact on power grid management. A recent study by McKinsey<sup>138</sup> shows that the expected ramp up of electric vehicles by 2030 should not cause significant increases in power demand, provided that smart grids are further developed.



**With €500 of tax advantages electric cars become cheaper for the first owner**



**Figure. Electric cars competitive total cost of ownership<sup>139</sup>**

While purchase prices for most EV models remain higher than comparable diesel and petrol cars, the total costs of ownership (TCO) appear to be lower taking into account how much it costs to fuel, maintain and insure the car. A study by the EU Consumer Organisation (BEUC) shows that by 2024 the average 4-year cost of running an electric vehicle will match that of a petrol car, and a diesel

one by 2030 with tax breaks of just €500 per year.

<sup>137</sup> <https://www.transportenvironment.org/what-we-do/cars-and-co2/publications>, Transport & Environment, Brussels, Belgium, 2018.

<sup>138</sup> <https://www.transportenvironment.org/what-we-do/cars-and-co2/publications>, Transport & Environment, Brussels, Belgium, 2018.

<sup>139</sup> <https://www.transportenvironment.org/what-we-do/cars-and-co2/publications>, Transport & Environment, Brussels, Belgium, 2018.



The impact of the conversion of the car making industry to electric vehicles is being intensively debated. According to the European Commission, CO2 emissions reduction targets should benefit the industry and could even help create 86-88,000 net new jobs by 2030. A recent study by Cambridge Econometrics, endorsed by BMW, VW, Daimler, Renault-Nissan and Toyota advocates that a shift to plug-in vehicles should create 206,000 net additional jobs in Europe by 2030, including in construction, electricity, hydrogen, services and most manufacturing sectors. The decline in job creation in the automotive manufacturing would then start declining after 2030.

Such figures are challenged by unions and others which point out to unemployment risks in many car-manufacturing region, especially within subcontractors. There are also fears that China, not Europe, might become a global manufacturer of EVs, causing massive job losses in the industry.

In the last 12 months alone (spring 2018-spring 2019), EU carmakers invested 7 times more into electric vehicle production in China than in Europe, owing largely to the Chinese EV quota policy. Setting a 2025 CO2 standard is urgently needed to accelerate investment and transition to e-mobility in Europe, which will secure industry long-term competitiveness and manufacturing jobs here.



**Illustration. Electric vehicles demonstrators and experimental charging stations in Russian Federation and in Belarus<sup>140</sup>**

### 5.3.2 The exponential rise of electric micro-mobility: temptation without regulation?

Cities across the world experience a rapid growth in the use of “small” electro mobility devices of all sorts, such as electric scooters, electric bicycles, Segways, gyroscooters, etc. While it is difficult to estimate to long term impact of such mobility devices on the environment and to evaluate the consequences on modal splits, individual electro mobility has become a global symbol of quality urban living. We have tried to list some of the main devices, although this market changes vary rapidly and is also prone to numerous other sorts of experimental vehicles, which cities try to regulate to save pedestrians.

<sup>140</sup> Belarus approved in 2018 a programme to create a state charging network for electric vehicles was approved. in compliance with global standards. The programme targets the deployment of 1.304 EV charging stations by 2030, the installation of 25 super-fast EV electric charging units in the cities under regional subordination (in Minsk and along the main highways with a distance between the two nearest stations of 120 - 150 kilometres) and over 25,000 cars by 2030

**Table. A tentative list of common individual E-Mobility vehicles and devices**

Device	Definition	Use	Notes
<b>Electro bikes</b>	Electric powered motorbikes	Same as a regular motorbike	Range: 50-100 km Maximum speed: same as a motorbike km/h
<b>Electric bicycle (e-bike, pedelec)</b>	A bicycle equipped with an electric drive that partially or completely propels it	Same as a regular bicycle. Requires no driving licence or license-plate number. May be operated by people of different ages and health status	Range: 25 - 50 km (rarely up to 100 km). Weight: 20 - 50 kg. Maximum speed: generally, up to 50 - 60 km/h
<b>Monowheel (unicycle)</b>	Electric self-balancing scooter with a single wheel and two stands.	Used as daily urban transport and for walking in a number of countries (China). Banned from use on roads in some countries. A unicycle rider is considered as a pedestrian In the Russian Federation	Weight: 8.5-22 kg Speed: 10 to 35 km/h Travel range: 10 to 130 km Riding requires protective equipment. Powerful monowheels are the safest
<b>Gyroscooter</b>	Self-balancing scooter, private electric vehicle. Different from the segway in that it has no steering column	banned from use on roads and sidewalks in a number of countries	Possible injuries in the event of a fall
<b>Segway</b>	Electric self-balancing vehicle equipped with 2 wheels on both sides of the driver	Can move on asphalt and soil. Used by police, postal workers. Fairly fast and manoeuvrable	Fairly expensive. Weight: approx. 40 kg. Mileage: up to 39 km Maximum speed: up to 50 km/h
<b>TWIKE</b>	Human-electric hybrid vehicle. Three-wheeled electric vehicle with an additional pedal drive. Sometimes viewed as a light electric vehicle	Operated on the road	Speed: up to 85 km/h Range: up to 150 km/h (without pedalling) Weight: approx. 250 kg
<b>Tricyclopod</b>	Three-wheeled motorised (usually electric) vehicle operated by one person in a standing position	Designed for short local trips on flat urban roads and sidewalks, shopping, police officers on patrol	Speed: 25-40 km/h



**Illustration: International Cargo Bike Festival, Groningen, June 2019.** <sup>141</sup>

<sup>141</sup> Source: <https://www.stichtingmilieunet.nl/andersbekekenblog/agenda/international-cargo-bike-festival-en-sump-congres-in-groningen-delivering-happiness.html>

### 5.3.3 Electric mobility in other dimensions: EV and drone passenger transportation?

Drone market forecasts vary considerably as they define the market boundaries differently e.g. military versus civil or commercial versus leisure use cases, but all agree that drones will be a multi billion-dollar market within the next five to ten years.<sup>142</sup>

A 2016 PwC global report on the commercial applications of drone technology estimated a volume of USD 127 billion for a civil-drone powered solutions market for addressable industries (measured by cost of labour and services that have a high potential for replacement by drones) (PwC, 2016). Goldman Sachs projected a global market size of USD 100 billion for the period from 2016-2020, which included a USD 13 billion forecast for commercial/civil operations and an estimated total spending on drones (both military and civil) of USD 17.5 billion in the United States, USD 4.5 billion in China and about USD 3.5 billion in the United Kingdom (Goldman Sachs, 2016). A 2018 global survey by Blyenburgh, (2018) identified an expected three-fold increase in missions for the transport of goods between 2017-18 (albeit starting from a very low base). It also identified passenger drones as a growing, but miniscule market and projected the outlook for the use of drones for market sectors such as construction, maintenance and remote sensing as stable.

Regarding the number of drones, a 2016 report by Gartner projected that there will be ten times more commercial drones than manned aircraft by 2020. This would mean about 230 480 commercially operated drones around the globe in 2020, when compared with the statistics for Boeing for 2016. These numbers are dwarfed by the projected global leisure drone fleet, which Gartner calculated at three million operative units in 2017. The firm also projected that the personal and commercial drone markets will increasingly overlap as technological breakthroughs allow the use of cheaper leisure drones for commercial applications.<sup>143</sup>



**Illustration. Airbus electric drone prototype at Le Bourget Paris Air Show 2019. Source: Air Journal / Airbus**

<sup>142</sup> Source. *(Un)certain Skies? Drones in the world of tomorrow*. ITF – CPB, 2018

<sup>143</sup> Source. *(Un)certain Skies? Drones in the world of tomorrow*. ITF – CPB, 2018





## Chapter 6.

# Promoting a new generation of Intelligent Transport Systems (ITS): making the case for Sustainable Intelligent Transport Systems

## **Chapter 6. Promoting a new generation of Intelligent Transport Systems (ITS): making the case for Sustainable Intelligent Transport Systems**

### **6.1 Continuous digital disruptions: where are we now with mobility and transportation?**

#### **6.1.1 Integrating plans and technologies is a priority**

The future of urban mobility depends on a nexus of infrastructures, mobility devices (collective, individual vehicles with very short or longer range) and IT systems. This nexus is being shaped by global trends and global players. The market of urban mobility has gone global and the most visible transformations are currently data driven. In practice, few cities have enough skills and resources to build their own way forward: the future of urban mobility is no longer a local issue.

The management of those combined transitions call for more integrated policy-making connecting urban and transport policies, such as through National Urban Policies (NUPs), combined with Sustainable Urban Mobility Plans (SUMPs), as defined by the European Commission since 2013 and with a new generation of SUMP 2.0 coming up in 2019.

In a video message shared at the Universal Assembly of UN Habitat which took place in the end of May 2019 in Nairobi, the UN Special Envoy for Road Safety Jean Todt pointed out that 1.5 million people die on the roads annually, and recommended *“regulating ride hailing services, advancement in transport technology and promoting infrastructure updates that prioritize non-motorized transport”* as priorities for the implementation of SDG11 on *Sustainable, safe and resilient cities*.

UN Habitat Assembly also endorsed the 2023 strategic plan of UN Habitat and its four priority areas:

1. Reduced spatial inequality and poverty in communities across the urban-rural continuum;
2. Enhanced shared prosperity of cities and regions;
3. Strengthened climate action and improved urban environment;
4. Effective urban crisis prevention and response

In that context, transportation and mobility systems are seen as a tool to reach more important goals. However, the Nairobi discussion does not account for a crucial point: the future of mobility depends on two superseding factors, the future of infrastructures, the future of the technology related to mobility and transportation.

At a special event *“innovative urban mobility for sustainable cities in Africa”* on May 31<sup>st</sup> 2019, participants discussed a huge diversity of possible solutions that meet the demand for more sustainable transportation in cities, from biometric data to measure cyclists stress levels in Nairobi to the connectivity between different mapping initiatives for high quality, transport related data generation and the development of behavioral measures aimed at reducing the carbon from the transport sector by encouraging people to rethink transport choices, delivered through digital technologies, etc.

Yet, the session never tackled the new industry/ technology and spatial planning nexus that is emerging from accelerated technological disruptions in the field of mobility. It did not address the effects of infrastructure planning on the future of mobility and transportation in cities.

The timeframe of future transportation systems is mid-term and long-term, which is also the time frame to measure the consequences of major industry and technology shifts. The challenge for public and private decision makers in cities, as well as for citizens and related organizations is to confront 10 to 15 years' orientations with a mounting pressure from daily issues.

The dependency of plans and policies on energy and industry change is impacting the future of sustainable urban transport and planning in an unprecedented way. Addressing the issue of sustainable transport and urban planning in 2019 and for the years to come means empowering local governments so that they can deal with technology and digital transformations and use them to reduce CO2 and GHG emissions, to manage urban growth.

### **6.1.2 Between sustainable transportation and sustainable planning, the key role of infrastructures**

Out of the bulk of existing frameworks and recent studies and reports on infrastructures, the *G7 Ise-Shima five principles promoting quality infrastructure investment* adopted in 2016 is being growingly acknowledged by governments, research groups, financial institutions, multilateral bodies.

This is illustrated by the *T20 Communiqué* of May 2019 ahead of Osaka June 2019 G20 summit. Moreover, the final communiqué of the G20 Osaka Summit held June 28-29 2019 underlines in its paragraph 13 the key role of quality infrastructures.

According to the T20 Communiqué adopted in Tokyo in May 2019, there is an urgent need for G20 countries (and beyond) to develop high quality infrastructure that is cost efficient over the life cycle, and maximizes the contributions to economic growth, the Sustainable Development Goals and environmental outcomes including impact on and resilience to climate. High-quality infrastructure should encompass all benefits and costs including spillover effects and externalities, with equal consideration to economic, social and environmental dimensions. The positive "spillover effects" of infrastructure, if well-managed, can boost GDP and tax revenue at the municipal, regional and national levels and in turn be utilized to address the gap between infrastructure demand and availability of finance.<sup>144</sup>

The *Ise-Shima principles* could well illustrate the way forward to further connect urban mobility policies and plans and build and manage the corresponding infrastructures, all the more if infrastructure development spill-over effects are well thought and managed.

#### **The principles of Quality Infrastructures**

**Principle 1:** Ensuring effective governance, reliable operation and economic efficiency in view of life-cycle cost as well as safety and resilience against natural disaster, terrorism and cyber-attack risks

**Principle 2:** Ensuring job creation, capacity building and transfer of expertise and know-how for local communities

**Principle 3:** Addressing social and environmental impacts

**Principle 4:** Ensuring alignment with economic and development strategies including aspect of climate change and environment at the national and regional levels

**Principle 5:** Enhancing effective resource mobilization including through PPP

<sup>144</sup> Yoshino, N., Bhattacharya A., Buchoud, N., Kovarik, J.B et al. *The economic effects of infrastructure investment and its financing*. T20 Japan Communiqué, May 2019



## 6.2 From ITS to Sustainable ITS?

### 6.2.1 The new face of ICT

In 2012, UNECE edited a special report exploring the role of Intelligent Transport System (ITS) in sustainable mobility. The then Secretary General of the United Nations Ben Ki Moon wrote in the foreword to this report that “Technology has been fundamental to transport throughout human history, but recent rapid advances in information technology promise to transform transport management in ways that would have been inconceivable until recently.” He also quoted Information and communication technology (ICT) as crucial for sustainable development, underlining the role of the transport sector in the global economy. According to this milestone report, Information and Communication Technologies applied to transport are therefore based upon a series of supporting communication systems, which can be considered as the foundations developing any piece of technological equipment or ITS service. These systems include:

- Telecommunication Networks (TLC).
- Automatic identification systems (AEI/AVI)
- Systems for automatically locating vehicles (AVLS)
- Protocols for the electronic exchange of data (EDI)
- Cartographic databases and information systems providing geographical data (GIS)
- Systems for the collection of traffic data, including Weigh-In-Motion (WIM) and systems for the automatic classification of vehicles.
- Systems for counting the number of users of a public transport system (APC).

Since the edition of the report, though, digitalization of the economy and the industry has moved forward quickly, not only in UNECE countries but globally. Several breakthroughs can be noted, such as:

- the convergence of CCTV monitoring systems and Artificial Intelligence (AI)
- the development of open data standards
- the emergence of new digital technologies such as blockchain
- the development of the Internet of Things (IoT) or “connected objects”
- the rapid move from 3G to 4G to 4G+ to 5G standards in mobile phones, with a debit of 1,9 Mb/sec for 3G, 150 Mb/sec for 4G, up to 1 Gb/sec for 5G
- the development of autonomous vehicles, on land, on water (robotaxis), in the air (drones)
- the development of industry 4.0

### 6.2.2 Dealing with mobility start-ups: “let us fix your urban mobility problems” ?

When dealing with ITC/ITS another factor needs to be taken into account. After disruptions in retail, in the press, in the advertising industry and many others, the globalised venture capitalist community has been looking in recent years for the next big opportunity and it believed it to be mobility. According to McKinsey, \$110 Billion has been invested in mobility startups between 2010 and 2016 with the most money going to startups in the sharing and autonomous vehicle spaces.

Not surprisingly the bulk of the investment has come out of Silicon Valley but the balance is shifting to South-East Asia and China, raising questions about whether Europe, Russia and CIS Regions, and Central Asia can follow the pace and take the lead. Building on contemporary technological and financial breakthroughs, Uber has raised a total of \$24 billion in over 22 rounds and hopes to go public in the summer of 2019. But Uber has challenges. It is burning through cash (in the second quarter of 2018, it lost \$891 million) and has increasing competition due to low barriers to entry.

Cities are also starting to question their offer of “let us fix your urban mobility problems”. New York was the first major city to limit the number of vehicle licenses after a study reported that

Uber was contributing to traffic. In Germany, Uber was briefly banned in 2014, and currently only operates in Berlin, Munich, Düsseldorf and Frankfurt. Uber's vision is to be the world's first private multi-modal operator moving commuters by bike, car, air taxi and autonomous vehicle in the future. Whether this is a vision shared by the public and cities alike, only time will tell, but this is a relevant illustration of the profound changes in mobility and transportation systems, that go way beyond the mere addition of a series of new technologies.

### **6.2.3 Assessing the complex effects of technological changes on urban mobility**

The impacts of the on going digital transformations in the field of mobility and transportation are systemic and huge, within a wider social context of a growingly digitalized society in all regions of the world. Until recently, there were two main mobility solutions - private car ownership and public transport. Subsidised public transport has been the only way to move large amounts of people with low pollution and congestion. Now there is the promise that the private sector, using apps and fleets of cheap light electric vehicles, can move people as effectively but without the cost to the city. Should cities forego the massive infrastructure spending and repurpose roads and parking bays for the new free-floating fleets?

Urbanites like to move at street level where they can see life on the street as they move. Urbanites like to move at street level where they visuals of street-life. Despite underground metros being highly effective mobility solutions they are used to save time or money compared to the preferred use of a car or taxi. Bikes, scooters and other light electric vehicles are giving urbanites effective low cost time saving mobility solutions, but they face numerous limiting factors, such as the lack of dedicated infrastructures and the need to share the road with car users.

Though public transportation is widely acknowledged as a way to move flow of people while limiting CO2 emissions, especially with the development of electric, gas, and now hydrogen powered vehicles, cities are facing a huge challenge as societal expectations and behaviours are changing. In North America for instance, the demand for public transport continues to decrease as Americans prefer to spend time in their car alone than use mass transport: according to the Washington Post, Transit ridership fell in 31 of 35 major metropolitan areas in the US in 2017.

The only way to change this behaviour is for cities to limit single user + single car ownership and/or driving while promoting attractive and accessible public transport and developing user-centric intermodal splits.

Cities can also implement more constraining regulations, such as high congestion charges, the elimination of on street public parking bays, and even reduce the size of streets and roads, etc. In principle, less cars in cities should free up valuable road surface to be repurposed for fleets of two-wheeled light electric vehicles that are able to move large amounts of people to an endless number of destinations.

To what extent these new technologies can replace expensive public transport infrastructure is unknown as no city has been able to reduce car ownership significantly enough to test the hypothesis. Moreover, solutions that might work in urban cores and in the center of metro areas might not easily address mobility needs at wider metropolitan and regional scales, be it for passengers, or for freight and logistics, where the use of individual car is still very much prevailing.

## 6.3 Transport in the era of (big) data

The availability of digital expertise and know-how does not rely only in multinational companies or existing public transit companies. Transport users increasingly demand cities to provide digital information, particularly real-time updates on their journeys. In the context of transport, the concept of smart cities revolves around a more integrated approach of data and urban transport provision, which raises the question of available norms and standards.



A growing source of data comes from the platforms that provide free and anonymized data from their own information, which can be used to understand travel patterns and complement other qualitative approaches as described here. The World Bank has recently launched an Open Data Platform (World Bank, 2016) which increases the availability of data from various sources. GIZ has also published a module on Open Data in the transport sector (GIZ, 2015).

Various activities are described with the term “travelsmart”, which initially was featured in Australia as an initiative to understand citizen’s mobility patterns and provide them with personalized improvements to their weekly trips. This normally implies a weekly travel log (people indicate the different trips, times and purposes during every day of the week) and, once they have finished, travelsmart experts provide them with alternatives in other modes (e.g. public transport, cycling, walking) that they could have used to do the same trips. This aims to provide users with an understanding of multimodality and that they can use other modes of transport for certain trips (not the same mode always, nor do they have to change to another mode forever). Research on this topic has shown that there are concrete and positive impacts in terms of mode shift (18% in cars in Japanese initiatives), CO2 emissions (19% reduction) and especially when linked to participants’ written plans (Fujii & Taniguchi, 2006; Zhang, Stopher, & Halling, 2013).



### Illustration Cycling as part of mobility systems. The Fiets Telweek in Flanders (Belgium) and cycling activism in Kiev (Ukraine)

Many cities have developed an activity that is very clear and straightforward to demonstrate the actual effectiveness of transport modes, called the “commuter challenge”. It consists of assigning a typical origin and destination and having people ride different modes of transport as they would in any day of the week – during rush hour – and demonstrate “live” who would arrive quickest. The trip must include also walking time to the vehicle, waiting time in platforms and parking and walking to the destination. Typically bicycles win these challenges, but in some cases motorbikes have won as well. Depending on the case, public transport and automobiles arrive latest. This is a great way to gather media attention as well, especially if it takes place during morning peak hour.

Various Dutch companies, NGOs and government allied to create a week where they could gather as much information as possible about bicycle use through the use of an app, called *Fiets Telweek* (National Bike counting week). This gave all stakeholders a very thorough understanding of how cyclists used their bicycle network and the times they did so, their speeds

and other characteristics of their trip. This enabled them to create policy proposals based on data, and also understand the needs of cyclists better.

A similar exercise is now being held in Flanders (Belgium). A similar initiative was held in Kiev organized by a cyclists Association, which was directly led by civil society and supported by other groups, and citizens were invited to participate according to a pre-defined schedule.

### 6.3.1 The development of open-data standards

The General Transit Feed Specification (GTFS) has emerged as a major standard to release public transit data around the world. As of 2016, approximately 1,050 transit operators released official GTFS feeds, while in 2015, Google, the historic co-founder of the system, listed about 5,900 agencies across the globe using Google Transit coverage tool. Most of the feeds are from operators in the US, Canada, Europe, Australia, New Zealand and Japan, but some are from developing countries. GTFS was initially co-developed by Google and TriMet, the transit agency in Portland, Oregon. GTFS feeds allow public transit agencies to publish their transit data in a format that is accessible to developers to access and write applications that consume the data. GTFS data can be used for trip planners, timetable publishers and a slew of other applications that use public transit information in some way.

Because GTFS is an open-standard, applications that are designed for one city's GTFS data can be used with any other set of GTFS data. This means that applications or analyses performed for one city's data can easily be performed and adapted for another city. It can be used not only to manage static transit information such as routes, stops and schedules, but GTFS-realtime (GTFS-RT) data feed specifications can provide live updates on transit feeds using Automated Vehicle Location (AVL) systems and static GTFS feeds. Apart from GTFS, SIRI, or Service Interface for Real Time Information is another XML protocol to allow distributed computers to exchange real time information about public transport services and vehicles. It was originally developed as a technical standard with participation from France, Germany, Scandinavia and the UK, making it a European standard, though GTFS is also largely used across Europe.

The development of open-data in the field of transport management is questioning data management, opposing "open-transport methods" to quoted "traditional methods", as summarized in the table below.

**Table. Principles of collecting open-data in the field of mobility<sup>145</sup>**

Transport Instrument	Traditional Method	Open Transport Method
<b>GIS Route and Station/Stop Locations</b>	Collect data using dedicated GPS device Manually upload data to desktop computer Use specialised GIS software to relate collected data to city's road network, enter details about the route Manually enter route meta-data Can only be updated by a GIS specialist	Staff ride transit route using mobile app Enter route and stop details using the app as they ride Data and meta-data automatically uploaded to accessible, central server Can be updated via a web-based graphical user interface
<b>Passenger Volumes by Location and Time of Day</b>	Stop locations manually marked on map, as well as alightings and boardings Stop locations plotted in GIS platform Passenger counts manually updated in GIS for each surveyed location	Survey staff can record boardings and alightings along entire route using mobile app. Data is saved with route information and automatically updated

<sup>145</sup> Source: World Bank Open Transport Team



<p><b>Average Travel and Dwell Times</b></p>	<p>Staff ride transit routes and measure travel time between pre-determined points on route map Travel time data manually entered on each route segment</p>	<p>Travel time automatically recorded and linked to route le</p>
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Regardless of the standard, open data can save both time and money in collecting such information about routes. Real-time service information including route and stop locations, passenger volumes by location and time of day, planned schedules, service disruptions, pricing and fare products, and average travel and dwell times can all be collected automatically or manually by staff. This information can then be automatically uploaded to an accessible, central server. In comparison, traditional methods require far more staff hours, manual work to record and upload information and advanced computer knowledge of programs such as TransCAD or GIS.

Opening data can empower resource-constrained transport agencies to collect high-quality transport data with limited effort and cost, as well as to conduct robust data analyses with minimal formal training in transport engineering and planning.

**Table. The principles of open data**

- In order for data to be considered open, it must be:
- Complete – all public data is made available, and is not subject to valid privacy, security or privilege limitations.
- Primary – data is collected at the source, with the highest possible level of granularity.
- Timely – it is made available as quickly as necessary to preserve the value of the data.
- Accessible – it is available to the widest range of users for the widest range of purposes. It must be available on the Internet.
- Machine processable – it is structured to allow automated processing.
- Non-discriminatory – it must be available to anyone, with no registration requirement.
- Non-proprietary – it is available in a format over which no entity has exclusive control.
- License-free – it is not subject to any copyright, patent, trademark or trade secret regulation. Mobility as a Service (MaaS): **from “owning mobility assets” to “gaining access to mobility”**, the development of consumer centric, data powered transportation models?

### 6.2.2 MaaS Principles

In the past two decades, there has been considerable progress in the area of integrated information, access and payment systems of public transport with regard to “shared mobility”. This is due, on the one hand, to new technical possibilities. Features such as electronic and contactless smart cards and increasingly digital solutions in conjunction with smart phones, are now enabling some of the following applications:

- Real-time information processing and networking (e.g. via app);
- Paperless verification (using check-in/check-out procedures);
- Situation-specific pricing (such as prepaid and post-paid processes according to best price methods, peak pricing, etc.);
- Cashless billing of user authorisations (by way of e-ticketing/mobile phone ticketing, for example).

These services offer something of a “countermodel” to the non-networked private vehicle. Notably in Asian metropolitan areas, electronic access systems have been intensively developed. In Europe, the concept of *Mobility as a Service (MaaS)*, that is “the integration of various forms of transport services into a single mobility service accessible on demand” (MaaS Alliance 2017)

is gaining traction, with a number of cities experiencing comprehensive data-based multi-mode mobility systems.<sup>146</sup>

In municipalities, MaaS creates a wide range of services for users and thus offer an alternative to the own car. The model contains and integrates components of concepts that already exist such as integration, interconnectivity and optimization of transport services as well as smart and seamless mobility. New concepts that have emerged through the Internet of Things and the sharing economy, such as the term “as a service” and personal modification of travel are also added.

The diverse means of transport options in the locally offered MaaS can be a variation of e.g. public transport, ride- car- or bike-sharing, taxi, car rental or lease. By providing a single payment channel instead of numerous ticket and payment operations, this comprehensive approach makes it possible to transform an existing in exible transport system into a more versatile structure. Ultimately, MaaS is a digital platform for end-to-end route planning, booking, electronic ticketing and payment services involving all means of transport regardless of whether public or private. The concept is based on a user-centric model that puts the demand first.

Customer contract and travel data - The aim is to configure a single interface with provision of services from all partners. The platform operator will have access to the customer's travel data, which is important in order to be able to respond to the customer's requirements and provide a exible system. One of the biggest security issues is data protection. Therefore, it's important for municipalities to set ground rules and regulations that address the equal access of all providers to travel data.

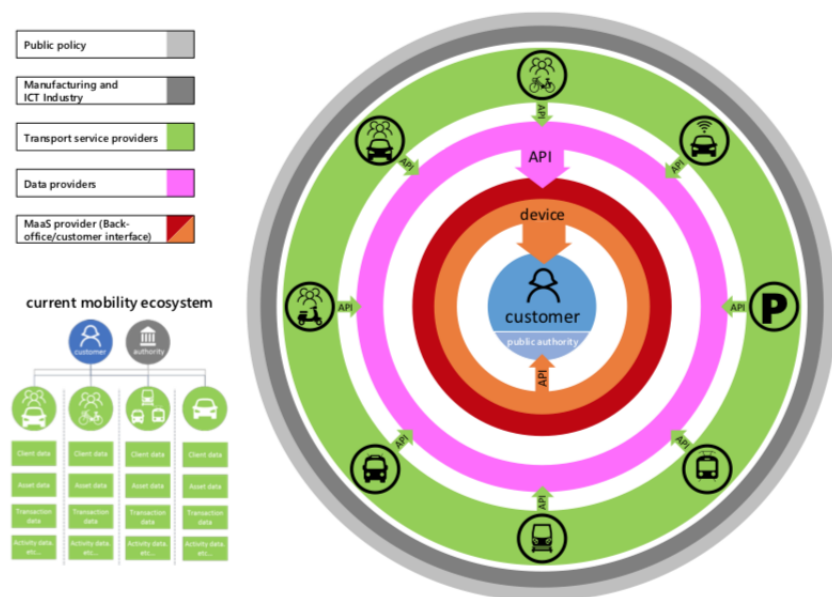


Figure. The Maas Ecosystem<sup>147</sup>

**Technical Infrastructure.** The Information and Communication Technology (ICT) is the backbone of the whole MaaS system. By creating an open technology architecture municipalities provide access to a dynamic mobility system. In this way, private partners can integrate into the system easily and new members can be added later on as

well. For the municipal authorities, this entails the establishment of regulations. It's necessary to authorize standardized technical infrastructure to ensure that sub-systems like parking management can be implemented easily as well.

<sup>146</sup> There are some online resources available to help cities by implementing a MaaS ecosystem: *MaaS Alliance: White Paper, Guidelines & Recommendations to create the foundation for a thriving MaaS ecosystem* [www.maas-alliance.eu](http://www.maas-alliance.eu), Deloitte Review: *The rise of mobility as a service, Issue 20 Reshaping how urbanities get around* [www.deloitte.com](http://www.deloitte.com), *MaaS Lab* The research team is part of the Urban Transport and Energy Group at University College London, [www.maaslab.org](http://www.maaslab.org), *WRI: Connected Urban Growth. Public-Private Collaborations for Transforming Urban Mobility*, [www.wri.org](http://www.wri.org), UITP: *Public transport at the heart of the integrated urban mobility solution A policy brief on new mobility solutions and public transport.* [www.uitp.org](http://www.uitp.org)

<sup>147</sup> Source: Blockchain and beyond. Encoding 21st century transport OECD / ITF-CBP, 2018 <https://www.itf-oecd.org/sites/default/files/docs/blockchain-and-beyond-encoding-21st-century-transport.pdf>

**Ensure a diverse MaaS service operator.** Implementing a MaaS system includes the requirement of precise coordination (fare integration, minimum service standards and service area coordination of demand responsive transport services).

In order to avoid privatisation of operation taking over the system, it is important to find a balance between public and private companies. Decision makers are therefore obliged to make all necessary adjustments to the existing and future services in order to achieve economic and ecological success (e.g. exclusive market access vs. allowance of competition). In this phase, the role of the MaaS operator should be determined, who sets everything in place and handles further communication between all parties.

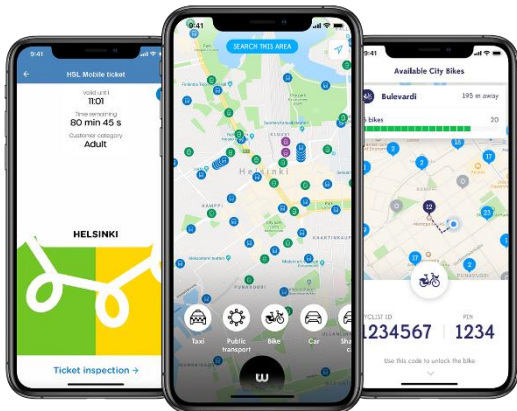
In the final phase the MaaS system is in place and needs to be operated on a constant level. Public authorities and government can now lessen control of public transport and let commercial partners take over more control. These enterprises often have widespread knowledge and understanding about user needs and travel behaviour. However, transport authorities need to retain a market overview and provide operational support for the involved parties.

**MaaS in practice.** It should not necessarily be the objective to create a MaaS ecosystem from scratch. Often a city does not yet have sufficient infrastructure or private mobility operators to create a system that offers a wide range of options. But an important step forward can be taken by enabling companies to settle down and prepare the necessary infrastructure. That way it becomes easy to take the final steps towards a dynamic and reliable MaaS model.

To understand the possibilities MaaS could provide a municipality with, it is beneficial to have a look at good examples of cities that have implemented such an ecosystem. Although most of the examples to date can be found in Europe, the topic is growing worldwide immensely. Intelligent mobility solutions are also becoming increasingly important at a global level and thus in emerging economies. In this sense, it can be seen as a stepping stone to a well-functioning city.



**Illustration: Dutch mobility innovations in 2018: Overview of the innovative concepts participating in the annual Accenture Innovation Awards 2018.** Source: BusinessMaaS, Sept. 2018



### Case study. The “Whim” MaaS platform in Helsinki (Finland): a forerunner

In Helsinki, Finland’s capital, an efficient and diverse public transport system already existed when the MaaS concept was intended to be integrated into the city. The city offers a wide range of alternatives to get from one place to another. MaaS Global, a start-up company founded in 2015, wanted to use MaaS to reduce the importance of owning a car by 2025 even more. The concept of Whim is a single integrated mobility app that can access different means of transport by purchasing a subscription and can also

handle ticketing if needed. As with the ownership of a car, users obtain the spontaneity to be able to travel easily. The overall effect of this concept is changing the way people move.

Within the app users can choose between three options. The first option is free of charge and single rides can be paid for in advance. The second choice is an offer including an unlimited public transport ticket and several rides on a car-sharing vehicle or a taxi. The last alternative provides an unlimited use of all vehicles. Those include public transport, taxi, car sharing and shared bikes.

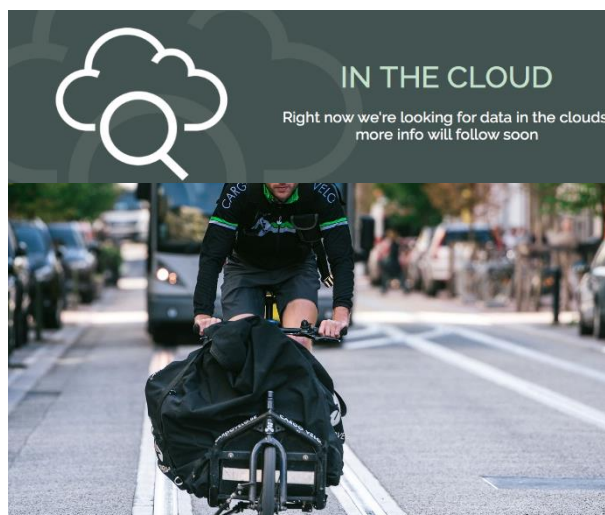
The company made its breakthrough when the local transport authority provided its open data as interface services and data packages. This case shows that an openly shared API (Application Programming Interface) is an important success factor to initiate the process in a city. Another big success driver that MaaS Global benefited from is the cooperation between private and public companies. Combining these facts Whim is constantly growing and gaining acceptance.

Traffic Management as a Service (TMaaS.eu) is an awarded urban mobility project driven by the Mobiliteitsbedrijf of the City of Ghent, has been selected by EU initiative Urban Innovative Actions (UIA) to receive financing. The Traffic Management as a Service-platform is a new and revolutionary traffic centre-concept for small and medium-sized cities. The European Commission will financially support the development of the Traffic Management as a Service-project by way of the UIA for a three-year period.

Setting up a traffic centre is an important part of the City of Ghent’s latest mobility plan (Strategic Mobility Vision 2015). The Ghent Mobiliteitsbedrijf developed ‘Traffic Management as a Service’, which is radically different from previous traffic centres: the Traffic Management as a Service-concept is based on a fully digital and virtual platform that processes traffic data and provides real-time information to the residents of Ghent. To achieve this up-to-date flow of information the data are dealt with and distributed to the users automatically, so operators are no longer required to continuously monitor screens.

The project aims to develop the Traffic Management as a Service-concept for the City of Ghent, and to operationalise a virtual and digital traffic centre. Current urban mobility centres are notoriously expensive, and focus on installing costly hardware in order to monitor traffic. Moreover, those systems are unable to provide personalised information to the city’s residents. The Traffic Management as a Service-system on the other hand uses data that are readily available from various partners and companies, and works multimodal. In other words: it takes all manner of transportation modes into account.





### **Case study. TMaaS, an award-winning project with global ambitions from Ghent (Belgium)**

To achieve this, the system automatically checks all data coming in on journeys by bike, bus, tram, train, or on foot. Based on those data the platform will send all information necessary to each commuter by way of social media, while considering each individual's personal preferences. Citizens are also able to provide

Traffic Management as a Service-platform with feedback. As soon as a problem arises, the platform will automatically take action.

Commuters will not only be informed about their journeys, they will also be notified of alternatives where necessary, enabling residents to travel in the most efficient, safe, sustainable and enjoyable way possible. Furthermore, City of Ghent employees will be able to monitor all mobility data, and use it to adjust traffic lights, inform residents, and evaluate and prepare mobility measures, among other tasks.

Current urban mobility centres are unable to provide local residents with personalised information. The Traffic Management as a Service system uses readily-available data from various partners and companies and is multimodal. In other words, it takes different means of transport into account, which will all be integrated into the user dashboard. To achieve this, the system automatically checks all incoming data about journeys by bike, bus, tram, train, or on foot, and based on this, sends the necessary information based on each individual's personal preference to each commuter via social media. What is also quite *revolutionary*, according to their promoters, is the fact that TMaaS is a unique collaboration between the government, industrial partners and universities.

### **Case study. Istanbul, towards metropolitan scale MaaS?**

Istanbul Metropolitan Municipality runs an online ITS system informing on the traffic situation and congestions. Data of traffic sensors at the principal and other main roads are real-time published by a traffic control centre via Internet.<sup>148</sup>

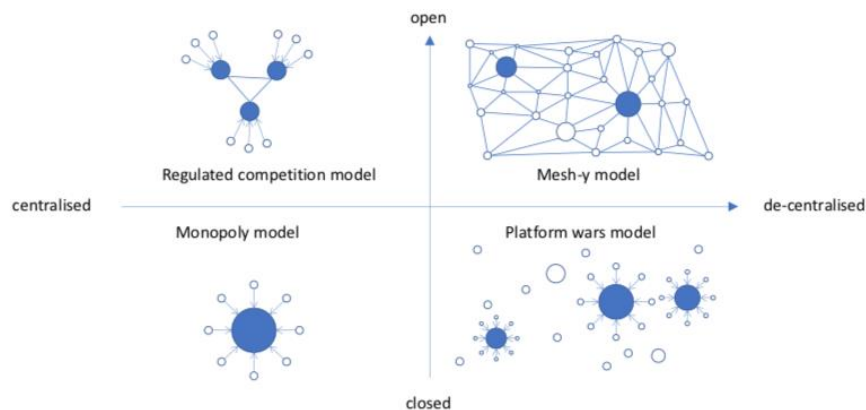
In all PT means, payments are done by either cash, by smartcards or by smart tickets. An easy-to-use smart ticket called '*Akbil*' is a plastic key with a refillable battery, valid on all buses, ships, sea buses, metro and tunnel systems and provides discounts from 10–25%. Contactless smartcards are available with discounts for subscribers, students, retired, or handicapped people. A 'Citizen Card' is being developed with the aim of handling more applications as car parking, e-health or event ticketing.

The smart ticketing features are of high value for PT and help to secure its success. Intended add-ons to the *Akbil* as e-ticketing will further enhance the popularity of this ITS. However, an easy handling must be kept and full applicability to all users including those not using Internet must be ensured. As an accompanying measure, every citizen should be provided with a free *Akbil* (nowadays a deposit of 6 TRL is to be paid).

<sup>148</sup> Source of the photo. Signature of Istanbul official statement by Istanbul Metropolitan Municipality (IMM) of joining R4E, the European funded Roadmaps for Energy, with Smart public transportation and Smart traffic management as priorities? March 2017

### 6.3.2 The next digital frontiers of mobility: blockchain etc.

Digital technology continues to reshape the transport industry. Recently, much discussion has focused on blockchain and other distributed ledger technologies (DLTs). Like other economic sectors, transport could be profoundly transformed by blockchain, and other novel DLTs that allow decentralised applications to run in peer-to-peer networks.<sup>149</sup>



Source: Adapted from (Casey & Valovirta, 2016)

#### Illustration. States of the market value systems of mobility as a service<sup>150</sup>

DLTs allow agents to enter into direct relationships with each other according to a commonly agreed set of rules and a high degree of trust without having to go through a central authority. Combined with a

common language and syntax for the “internet of mobility” and new means of deriving insight from previously siloed data, these applications may help redefine how people access, pay for and use transport in their everyday lives.

Urban mobility today is a siloed world of separate and independently regulated services. The application of distributed ledger technologies, such as blockchain, to urban mobility may lead to a future more aligned with other “as-a-service” models where actors engage directly with each other based on commonly agreed protocols.

These changes will also challenge public authorities. They must keep abreast of developments in data science and DLTs to adapt current regulations where they hinder beneficial outcomes. They must also explore new regulatory responses where these are necessary to deliver the outcomes the public wants.

The deployment of DLTs is still very much in its infancy, especially in support of Mobility as a Service (MaaS) and yet the OECD International Transport Forum has recently issued a series of recommendations to manage the way forward, showing how much regulation will matter... and call for high level government policy-making standards in the field of transportation and mobility:

- Take into account changes in data science and technology when developing Mobility as a Service
- Look beyond initial cryptocurrency applications of distributed ledger technologies
- Governments should help deploy the building blocks that enable wider uptake of distributed ledgers
- Apply blockchain technology now for slow and (relatively) small transport use cases; anticipate next generation distributed ledger technologies for “big and fast” applications to be deployed later
- Governments should develop algorithmic code-based regulation to accompany the uptake of distributed ledger technologies

<sup>149</sup> Source: Blockchain and beyond. Encoding 21st century transport OECD / ITF-CBP, 2018 <https://www.itf-oecd.org/sites/default/files/docs/blockchain-and-beyond-encoding-21st-century-transport.pdf>

<sup>150</sup> Source: Blockchain and beyond. Encoding 21st century transport OECD / ITF-CBP, 2018 <https://www.itf-oecd.org/sites/default/files/docs/blockchain-and-beyond-encoding-21st-century-transport.pdf>

## 6.4 A review of common digitalization of mobility and transportation systems

### 6.4.1 Common ITS regulation in UNECE countries?

Intelligent Transport Systems can give cities a new approach to the use of available resources and infrastructure as advanced technologies can facilitate the sustainable operation of existing infrastructure with moderate expenses incurred, which in turn could assist in reducing the need for new construction.

Intelligent Transport Systems can help solve issues related to improving road traffic efficiency in a prompt manner with immediate outcomes. In addition, newer technologies that use big data analytics, automated and connected vehicles. With a growing number of national and local initiatives, the demand for intelligent transport systems development in the UNECE region is mounting.

A sound regulatory framework is crucial for the overall management of the planning, implementation and delivery of services provided by intelligent transport systems and for managing them in compliance with relevant standards and requirements. Explicit regulations can further facilitate effective policy-making, sound investments and consistency in technology development. For example:

1. Only few UNECE Member States of the region have regulations directly related to Intelligent Transport Systems. Still, the definitions and descriptions laid down in such regulations do not necessarily meet specific system requirements. There is a need to update existing regulations to address issues related to Intellectual Transport Systems in order to support faster and more coherent development;
2. In accordance with the institutional arrangements, the regulatory requirements envisage the involvement of different entities, including not only transport - related agencies but also agencies that deal with technology. At times, this leads to inconsistencies in regulations, which may hamper the coordinated implementation of systems, the installation of compatible systems, the justified prioritisation of services provided within the scope of Intelligent Transport Systems and the planned allocation of funds for technological projects;
3. Recent improvements in the technology of Intelligent Transport Systems herald dramatic changes in urban transport systems. One of the latest most revolutionary technologies, as emphasized above, is the production of autonomous vehicles. Existing regulations do not adequately reflect the emerging technologies for the production of autonomous vehicles due to the diversity of autonomous vehicle systems. Given the widespread proliferation of autonomous vehicles in the near future, policy makers in the region need to understand and discuss specific regulatory issues related to autonomous vehicles such as, for instance, the ways in which autonomous vehicles and traditional vehicles are reflected in regulations as well as operational aspects of autonomous vehicles that require regulation.

Many Member States are implementing projects in the field of Intelligent Transport Systems, whose success requires significant support for their implementation. Besides helping address urban traffic issues, the introduction of Intelligent Transport Systems can produce a positive impact on the environment and development.

All across the UNECE region, regions and cities are testing and implementing smart transportation projects, ranging from smart public transportation to seamless multi-modal mobility. Although there can be great differences in the size and duration of investments, the trend is towards the generalization of e-ticketing and large-scale comprehensive approaches to mobility systems.

In the case of Istanbul or Moscow, long term transport and mobility policies include not only expanded public transit networks but also the development of new road infrastructures. In the Paris Region, the masterplan approved in 2014 has ruled against the expansion of the road network to prevent sprawl. In all cases, traffic congestion is a major challenge and municipal and metropolitan authorities tend to reject traffic out of the urban cores.

In the near future, automated ground mobility vehicles, including private cars and public vehicles, might be a durable game changer, even if in the next 5-10 years, it might just add another level of complexity to transportation and mobility networks driven by consumers' choices and public budget constraints.

### **Case study. Moscow “Innovative Mobility” project**

ITS in Moscow include: road user information subsystem, automated traffic management system, photo and video recording and televiewing system. ITS are designed to harmonize the traffic flow, as well as to ensure a rapid response to emergency situations. Currently, 100% of the territory of Moscow is covered by Intelligent Transport Systems.

Beyond that, one can get information about the routes, traffic intervals, up-to-date data on the traffic of buses, trolleybuses and trams, as well as the estimated time of arrival of transport vehicles at stations through the mobile application “Mosgortrans”.

At the same time, since 2018, Moscow metro cars have been equipped with passenger information screens (currently 8.720 screens in more than 230 trains, 4-8 screens per car). Substantial operational information about the operation of urban passenger transport is prioritised so it is broadcast online. One of the primary channels of engagement and provision of information about the operation of transport is social networks: (VKontakte (vk.com), Twitter (twitter.com), Instagram (Instagram.com), Facebook (facebook.com), Odnoklassniki (ok.ru)<sup>151</sup>.

The Moscow “Innovative Mobility” project displays a “all mode” approach with the development of a new road network, the development of car-sharing and autonomous vehicles, the development of cycling, a reform in the taxi sector and more attention paid to the comfort of living while commuting.<sup>152</sup>

The Moscow Central Ring (MCC) in Moscow (Russia), a joint project of the State Unitary Enterprise “Moscow Metro”, Open Joint Stock Company “Russian Railways” and Joint Stock Company “MKZhd”, is intended to become an integral part of the modern transport system of the city distributing passenger traffic in the capital of Russia.

The Moscow Central Ring has 31 transport interchange hubs; each of them providing a transfer to on-ground public transport. On both sides of the railway there are convenient access roads, turning platforms for buses, and new stations.<sup>153</sup>

Passenger traffic was launched on the Moscow Central Ring in 2016. Until 2020, it is planned to develop the areas adjacent to the transport interchange hub Moscow Central Ring. Thus, abandoned industrial areas are to be redeveloped, including economic activities and housing. At last, the MCC project is part of a larger *Smart Moscow 2030* comprehensive project addressing the digital transformation of the metropolis in all sectors, not just mobility.

Other large scale projects are being implemented throughout Europe such as in London, Paris or Amsterdam. Meanwhile in the Randstadt metropolitan region (as well as throughout the whole of the Netherlands), railway connections are gradually shifting from timetables to regular intervals.

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<sup>151</sup> According to the response of Moscow (Russia) to the UNECE questionnaire.

<sup>152</sup> <http://transport.mos.ru>, Unified Transport Portal of Moscow (Russia).

<sup>153</sup> <http://mosmetro.ru/mcc/ps/> In total, the Moscow Central Ring has 177 pairs of trains circulating per day on weekdays, and 150 pairs on weekends. With the capacity to accommodate 1.500 passengers, electric trains “Lastochka” are adapted for people with reduced mobility, passengers travelling with children and are convenient for transportation of bicycles and baby strollers. The trains are equipped with toilets, climate control and Wi-Fi



**Case study. Smart transport in Minsk (Belarus) and in Tatarstan Republic cities (Russian Federation)**

In the Republic of Belarus, road passenger transport operators widely use automated systems of dispatching control and passenger transport operations control by advanced means of information and communication, which allows for coordination, control and management of traffic of all modes of transport on the route network.

In 2014, Minsk kicked off the implementation of contactless smart cards and a system of automated payment and travel control for urban municipal passenger transport. This system allows for trips to be paid both by a paper one-time ticket (coupon) by marking it in an electronic compost, and by an electronic travel ticket (contactless smart card) by marking it in the validator.

Passengers are now able to use a single tool to pay for services of all types of urban transport, one that is easy to obtain, top up, as well as being able to use a smart card and pay only for those trips that have actually been made.

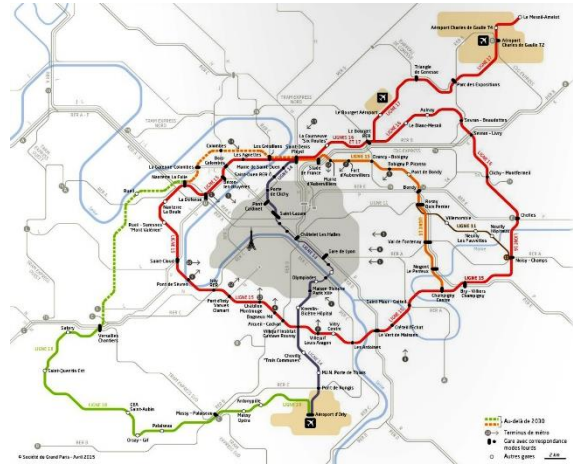
In particular, State Enterprise “Minsktrans” uses the Internet services of “Virtual Timetable at Stations” and “Rational route” to find the optimal route, taking into account the traffic of public transport in real time<sup>154</sup>.



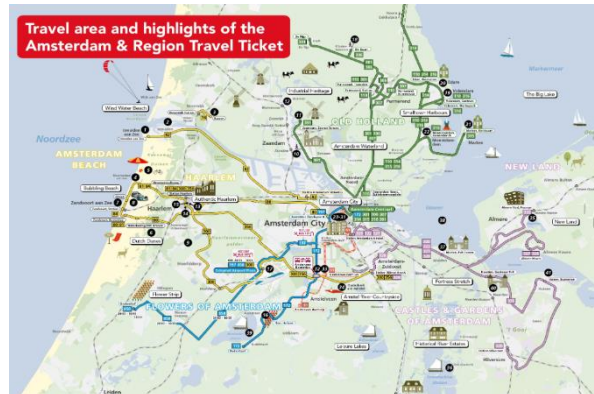
<sup>154</sup> Based on the answers given by the Republic of Belarus to the UNECE questionnaire.

**Illustrations. The Moscow Central Ring, a forerunner of a new generation of integrated mobility infrastructures and systems at large metro scale (Cross-rail in London, Grand Paris Express in Paris, Amsterdam comprehensive bus and train integrated system)**

Moscow Central Ring (launched in 2016, scheduled to be completed in 2020)

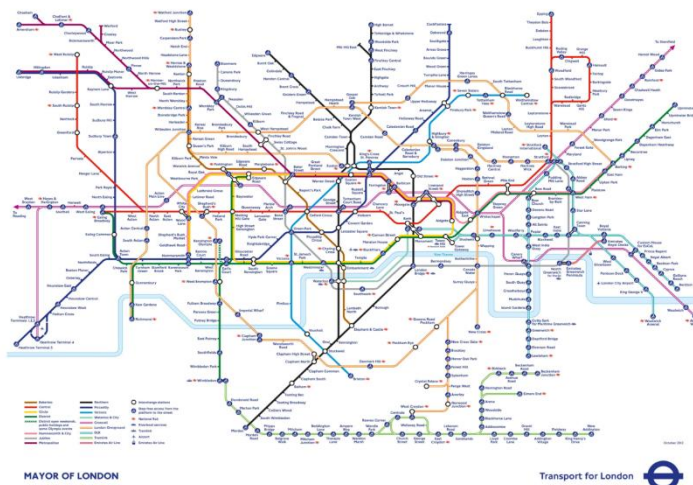


Grand Paris Express new network (scheduled in different phases, with the first segment to operate by 2020/4/5)



Amsterdam metro area smart mobility system includes train, bus, roads

London Crossrail «Eilizabeth Line» (scheduled to operate by 2020)



### 6.4.2 CCTV can be used to regulate traffic with a very fine grain

A most striking feature in traffic management is the development of CCTV, which goes much beyond that sector to include safety, security and social control aspects and it is not the UNECE region which leads the way.

As of 2017, there were 170 million CCTV across China, with an expected rise to more than 400 million by 2020. In 2015 in Beijing, the police claimed a coverage of 100% of the city, as part of SDkynet, the designated nation-wide system. Though the situation in China is rather unique, it summarizes a global trend in major and even mid-sized cities across the globe, such as in Europe or in Central Asia. In France, the city of Nice has unveiled in 2018 a comprehensive CCTV system managing not only traffic, but also public-space, a system mobilizing local, national and European funds as well as a wide array of private companies in the field of road safety but also biometry etc. In 2019, the city of Dijon has unveiled an integrated smart city command center including traffic management, energy management and other factors. Examples out of the UNECE region of limitations of such integrated command centers, such as in the city of Bandung in Inodonesia show that the management of political and social factors are as important as the initial technological inputs.

- **Thales Communications & Security chef de file** : apporte sa capacité à transformer de nouveaux concepts d’opération en solution durables et innovantes, à manager des projets complexes et à intégrer des grands systèmes. Il intègrera la solution fédératrice. Il apportera le système de gestion de la ville et d’analyse des données multimédia ainsi que la solution de patrouille connectée.
- **Arclan** : spécialiste de la protection des sites
- **BCA** : intégrateur de système d’accès
- **Deveryware** : spécialiste de l’alerte à la population
- **Egidium** : spécialiste des postes de commandement
- **Gemalto** : Expert en sécurité digitale et en biométrie
- **Geol Semantics** : expert de l’analyse des textes
- **IGO** : expert de la gestion des données 3D et de leur affichage
- **INRIA** : spécialiste en simulation microscopique de foule
- **Luceor** : spécialiste des réseaux radio wimesh haut débit
- **ONHYS** : spécialiste de la simulation de foules
- **IDEMIA** : spécialiste de la sécurité routière
- **SIS** : spécialiste des postes de commandement
- **Sysnav** : expert de la géolocalisation
- **Yncréa Méditerranée**: spécialiste en analyse vidéo et technologies sans contact

**Figure. The industry partners of Nice (France) safecity/sensecity samrt city project**

In practice, it is difficult to imagine running exiting metro areas and complex urban systems without CCTV monitoring. In the Paris Region, a network of over 1,000 CCTV cameras provide the basic infrastruucutre of SYTADIN, the

regional traffic management system. In Istanbul (Turkey), the Intelligent City System started with 6 cameras in the Taksim Square and it now counts over 300 units across the metropolis, managing 3,5 million vehicles in the traffic, pedestrian flow, public transport buses, minibusses, taxis, school services, earth moving trucks, and everything else involved. With CCTV, it is much more than numbers. Additional features are being added to the systems, including face recognition in the public realm. Regarding traffic management, experiments are going on in several cities and regions. In the Paris Region, new cameras have been installed in 2018 to monitor car-sharing, following an experiment at the French-Swiss border in 2015 in the border city of Jougne.

In Istanbul, the traffic management system also works with sensors on the road, allowing to inform citizens and drivers of situations such as snow, rain, storms, icing, etc. According to Istanbul metropolitan government, the smart traffic management system has allowed to decrease traffic congestion by 17% in 2018 as compared with previopus years, in spite of an increase of vehicles per capita is increasing of %4,5 every year. As illustrated by the Pairs or Istanbul cases, CCTV systems come with many other features, such as the control of parking violation, the control of passengers within public transit tec. Centralized and integrated Transportation Management Centers (TCM) are only the visible part of complex management



systems including several different public authorities and public and private technology providers.



**Illustration. CCTV monitored traffic is now common in cities**

The development of CCTV comprehensive traffic monitoring systems allows for more sophisticated toll systems, including toll systems in free traffic flow, satellite-based area-wide toll systems, lane-based toll systems, city toll zones based on video, DSRC or GPS/GSM technology. Until recently, the deployment of a toll system was anything but a simple project. And for every new route section added to the tolled zone at a later point of time, recording stations, kilometers of cable, and rows of video cameras had to be added. Technology providers now tend to value other sets of solutions such as through global navigation satellite systems (GNSS). Thanks to such technology, *“the position*

*of every vehicle can be determined accurately, so any road or street on earth can be included in a road pricing system without the need for local infrastructure”*, according to Siemens. Such new electronic toll solutions offer the operators opportunities to develop new services. In principle, they also offer more flexibility such as flexible toll fee definition depending on the time of day, the vehicle’s emissions standard, the distance traveled or the road category. The system can also be used for enforcing compliance with environmental zones.

**Illustration. CCTV monitored traffic is being developed in cities where traffic is quickly growing such as Tashkent (Uzbekistan)**

In Central Asia’s largest city, Tashkent, which count over 2,5 million inhabitants, a combination of factors is pushing towards a rapid increase of the number of cars in the streets, without corresponding traffic control measures. The United Nations Development program is currently (starting in 2018) supporting the deployment of CCTV at the city’s major crossroads, to measure and manage traffic. Up until recently, there were no traffic monitoring cameras at all in the city.



**6.4.3 Smart traffic-lights: from controlling flows to supporting eco-mobility**

Traffic light phasing has a significant impact on the flow and safety of traffic. In the past few years, traffic light programming has been pushed towards more benefits for eco-mobility but there is more potential to be tapped into. In this context, maximum waits for those who are walking, cycling or using public transport should be as brief as possible. A register of intersections, serving as a basis for the programming of traffic lights by way of weighting e.g. modes of transport as well as their capacities and frequencies, is an important instrument. The intersection register is an internal guideline for planning, standardising planning principles for



traffic light phasing and supporting the idea of giving priority of eco-mobility. The intersection register is closely connected with the classification of transport networks.



**Case study. Smart traffic-light in Vienna, a role model city in smart traffic lights**

At present, Vienna in Austria has about 1,300 traffic light installations. This large number stems from the wish to “get a grip” of traffic by control, an issue which prevails in most cities across Europe and UNECE region. Traffic lights often only provide a subjectively perceived level of safety, and they induce people to rely fully on them on the one hand, or to break the rules on the other, e.g. by crossing against a red light, thus causing conflicts between

traffic participants.

Organising intersections at spots with low traffic density without traffic lights fosters coexistence in traffic. Based on the *Rules of the Road*, the flow of traffic can be improved by responsible self-organisation. This way, unnecessary waits and rule-breaking are reduced. The safety of all traffic participants can be ensured by structural and/or organisational measures. Structural measures may include “pavement crossings” or the elevation of intersection centres. Due to the fact that roundabouts need much space, it is not often possible to build them in inner-city areas. Usually, simpler, cheaper and more space-efficient measures are entirely sufficient; they create more direct routes for pedestrians and are thus more purposeful. Intersections crossed by public transport can be equipped with amber/red traffic lights for needs based control of traffic.

The intersection register in the pipeline is to provide information about the locations where traffic lights are not absolutely necessary (in respect of existing and planned new installations) or where operating times could be reduced. Traffic lights are to be removed in selected locations under pilot projects.

**Using traffic lights to support eco-mobility**

Traffic lights and signs are essential for traffic regulation. The shortest possible maximum waits for pedestrians and cyclists become a growingly important target in the programming of traffic lights. To this end, the cycle times of traffic lights are to be shortened as a matter of principle; long cycle times should be limited to rush hours. Traffic light cycle times can also be reduced by a minimisation of distances covered by pedestrians when they cross streets. In this context, safety is enhanced, and it is ensured that slower pedestrians have enough time to cross. Distances can be shortened by e.g. removing less used turning lanes. Lead times for pedestrians are to be recorded and taken into consideration in calculations to improve on criteria such as subjective safety in respect of crossing time.

At present, the smooth flow of motor-vehicle traffic has high priority in the programming and coordination of traffic lights (“phased traffic lights”). In the future, intelligent traffic light programming is to support eco-mobility in that it takes the needs of all traffic participants into consideration. Existing measures are to be expanded, including more lead time for pedestrians before motorised traffic turns, special phases in which public transport means can pass intersections without having to stop at all or with fewer waits and longer green light phases for cyclists.

**Case study. Münster adaptive signal control system, a benchmark in Germany<sup>155</sup>**

To control the high proportion of cyclists, special traffic lights and signs are required. In Münster (Germany), bicycle traffic is managed by three different types of traffic lights at all major intersections. The first of regulation is a separate traffic light for cyclists. At some intersections, this is complemented by an arrow within the light that assigns the direction of turn.



The second the third types are usually combined with traffic lights for motorised traffic.

In addition to the regulation by traffic lights, there are special traffic signs. Every facility or preference given to the cyclists, e.g. at dead ends, pseudo one-way streets or pedestrian areas, need to be clearly indicated by signs. Furthermore, there are signs for “Dead angles”, special regulations at bus lanes or indicating bi- directional cycle ways, etc.

Cyclists have an intersection clearing time similar to that of motorised traffic. Separate signaling for pedestrians and cyclists contributes to make cycling more attractive. In addition, the “clearing time traffic lights” which have stood the test of the pilot project should increasingly be used at focal intersections. Pelican crossings should be used as sparsely as possible. If needed, the traffic light has to respond quickly to pedestrians wishing to cross to keep waits as short as possible and keep pedestrians from crossing before the light has turned green. In advanced cities such as Copenhagen or Vienna, traffic light phasing has allowed to give right of way to public transportation and cyclists. In Copenhagen, it is now possible to cross the city-center by bicycle at peak hours without a single stop.

**Phasing traffic lights to privilege public transportation**

Traffic lights phasing is also becoming an integrated part of transport master plans to privilege public transportation under the principle “no stopping unless it’s a stop – systematic right of way to trams and buses.” In this context, various flows of traffic are prioritised according to the classification of transport networks

Beyond the technological complexity of managing phased traffic lights at large scales, what is most important is the impact on user’s choices. The acceleration and priority to public transport must result in an actual perceived shortening of door-to-door transit times for passengers in the future. In this regard, the comfortable and safe use of public transport is also closely linked with the design of accessways to and exits from stops. Smart traffic light phasing may contribute to this, especially when stops are located on traffic islands or at intersections.

Apart from the actual acceleration of public transport, in particular in inner-city areas, the regular operation of public transport lines in keeping with the timetables (e.g. reliable intervals in rush hours and adherence to times tables early in the morning and in the evening) is a crucial factor for the appeal of public transport. More advantages come with ultra-low floor vehicles as passengers can enter and exit quickly. Innovative technology also enables dynamic prioritisation of public transport depending on the traffic situation. Trams or buses running early or late can be considered, e.g. by linking the computer-based operation management system.

In short smart traffic light management can only be successful as part of a series of upgrades in the transportation network, including the design of exits and stops, the design of the vehicles (buses, or trams), the design of intermodal stations.

Another option for the acceleration of public transport is a classification of the bus network according to lines essential for the network structure – i.e. major fast lines operating at shorter

<sup>155</sup> Source of the illustration. Siemens

intervals and fulfilling higher quality standards – on the one hand, and standard lines on the other hand. Accordingly, high-quality bus corridors are to be planned even before construction in new urban development areas starts so that the new developments are well connected even if there is no underground or tram axis in the vicinity. These high-value bus lines essential for the network structure should then be subject to the same acceleration criterias as trams.

Traffic light phasing has a significant impact on the flow and safety of traffic. In the past few years, traffic light programming has been pushed towards more benefits for eco-mobility but there is more potential to be tapped into.

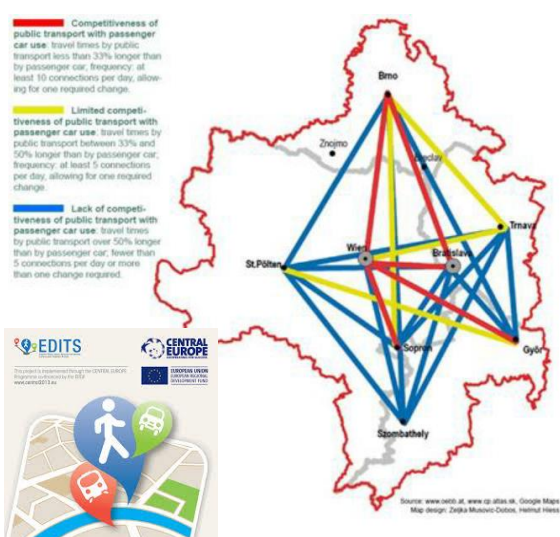
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### Developing cross-border traffic lights and mobility standards

In many cases, urbanization and regional development has become a cross-border issue throughout Europe, such as in the Eurodistrict Strasbourg-Ortenau across France and Germany or in the designated centroepe region connecting Austria, the Czech Republic, Hungary and Slovakia. The centroepe region with its centres Vienna, Brno, Bratislava, Győr and Sopron, has a string potential for further economic and demographic growth. With this in mind, several processes were completed or are underway to determine foreseeable action

Several processes and projects have produced a long list of proposals and ideas to shape freight and passenger mobility in the region in a sustainable and effective way. The Strategy for the Danube Region as a coordinated supra- regional strategy of spatial planning and transport development forms the framework of further and more specific processes and projects. Further processes are based on this strategy. From the angle of the provinces of Vienna, Lower Austria and Burgenland, the following initiatives are particularly relevant:



### Illustration. Smart cross-border traffic control in centroepe region

Cross-border intermodal traffic information system The time-tested regional transport and traffic information system for the Eastern Region, AnachB.at, which also includes a route planner, is popular throughout Austria and even Europe. Good information is of paramount importance when you have to change mode of transport during a trip. Mobility information is thus to be made more readily available to travellers in the entire centroepe region step by step. The long-term goal is to expand a service in analogy to AnachB.at across the centroepe region which gave birth to another project, the “European Digital Traffic Infrastructure Network

for Intelligent Transport Systems” (EDITS) funded by the European Union. EDITS prepares the ground for cross-border multi-modal traffic information systems. Based on existing platforms, specifications and systems are being created for data exchange.

To change mobility behaviour, it will not be enough to offer services. Awareness-raising measures will also be required. Information about alternatives is needed for personal decisions on mobility. The three provinces intend to take joint action in the fields of awareness-raising and

information, to include an inter-modal information system, also bringing in multi-modal mobility, a new, customer-oriented and simple system of pricing (subject to a price reform) which responds to the individualisation of society and comprises differentiating target-group oriented services, the integration of micro transit in the public transport information system.

On the whole, the trend towards personal multimodality is to be supported by a comprehensive mobility information system.

### **Smart traffic without smart traffic lights and without electronics**

Since September 2010, the “Lindenkreuzung” intersection, one of the most important transport hubs in Dornbirn, has not been equipped with traffic light anymore. Prior to the redesign, the intersection, which is frequented by 13,000 vehicles (including numerous buses) every day, was criticised for long waits, advanced stop areas which were too small and traffic jams. The number of pedestrians and cyclists was higher than that of cars. In the beginning, traffic light phasing was continuously optimised. However, it turned out to deteriorate the situation for buses and pedestrians.

#### **Illustration. Redesigning infrastructures without electronics: the Lindenkreuzung intersection in Dornbirn (Vorarlberg, Austria)**

In the course of redesign, the intersection centre was elevated and the traffic lights were removed. Conspicuous surface markings were added. The new organisation of traffic is now merely based on the “priority to the right” rule. After redesign, the flow of traffic became smoother and capacity increased because waits are shorter for all traffic participants. There are hardly any more traffic jams and peaceful coexistence can be observed. Accident statistics have shown that 2-3 accidents happened annually in the years 2004-2007. From 2009 to 2013 no accidents were registered. The removal of traffic lights has also saved money for maintenance expenses per years.

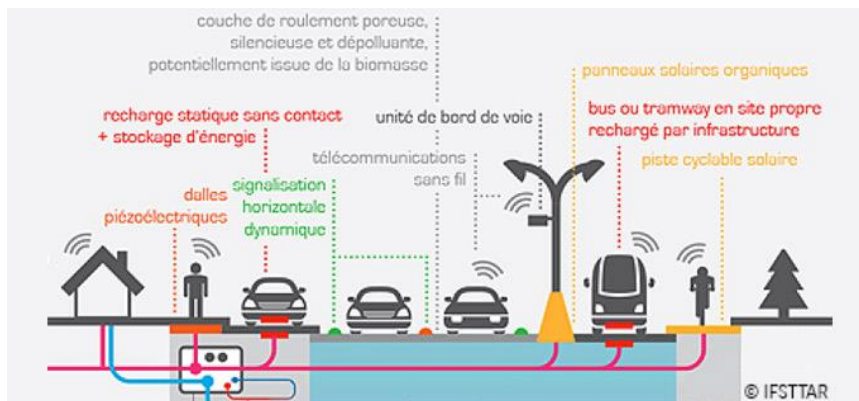


## **6.4.4 Traffic modelling through simulation and evaluation**

### **Simulation: from users to infrastructure design**

The development of digital technologies in the field of mobility and transportation allows not only to set up better traffic control procedures. It also helps build much finer grain traffic modelling and simulation. Conventional traffic simulation models generally represented only a limited part of a city's street geography and travel. For instance, car travel is fully represented in a traffic model, but travel by public transport may be incompletely represented, and pedestrian/cycle travel is often missing altogether. This means significant groups of “users” are invisible in the assessment. Integrating motor vehicle models with models of public transport travel (bus, tramway, metro and train networks) as well as models of pedestrian and bicyclist networks is critical, however, for comprehensive exposure assessment. Yet, the combination of centralized data management systems with open-data opens up new ways to elaborate more complete mobility simulation modelling including all uses.





**Illustration. Redesigning infrastructures including all mobility modes. The R&D project of 5th generation road<sup>156</sup>**

The impacts of user centric traffic modelling are so strong that it now has impacts on mobility and transportation infrastructure design and engineering, as

exemplified by such projects as the “road of 5<sup>th</sup> generation” developed by a consortium of research and industry leaders in France.

### Monitoring and evaluation

While most “impact assessment”, as such, is prospective, retrospective assessment can play an important role in transport and health assessment. Monitoring and evaluation tools support retrospective assessment by analyzing trends in transport and correlating those with environment and health trends and outcomes. Retrospective assessment may involve processes such as health impact assessment, and a range of quantitative and qualitative tools. However, routine and rigorous monitoring and evaluation can often be performed most efficiently through the use of standard indicators and indices (Ness *et al.*, 2007).

For example, while vehicle traffic volumes are usually recorded and reported systematically, similar data on volumes of pedestrians/cyclists using the transport system is often not routinely collected by Transport Ministries. Similarly, data on vehicle crashes may be routinely collected by police, less so data on pedestrians injured or killed by vehicles. Infrastructure ministries may report upon kilometres of road paved annually; similar indicators for sidewalks or bike paths are slim to nonexistent in most developing countries and much of the developed world. Nor is data routinely collected on social well-being factors such as pedestrian traffic in correlation to crime or measures of neighbourhood cohesiveness. Consideration of health requires that essential data on transport-related human health and social factors, and not only vehicle data, be collected and monitored in a balanced transport indicator set (TRB 2008). Collecting and reporting indicator data allows public assessment of whether transport systems are moving in the right direction, whether progress is rapid enough and thus whether the right policy settings are in place.

Given the evidence that socioeconomically disadvantaged groups typically bear more of the burden of transport hazards and also have poorer access to current transport systems, the social distribution of transport effects should also be monitored as part of such health-oriented analysis.

One example of a formalised transport and environment indicator set is the *Transport and Environment Reporting Mechanism (TERM)*.

Through the Transport and Environment Reporting Mechanism (TERM) report, the European Environment Agency has been monitoring progress in integrating environmental objectives in transport since 2000. The TERM report provides information to the EEA's member countries, the EU and the public and it includes several indicators used for tracking the short- and long-term environmental performance of the transport sector and for measuring progress towards meeting key transport-related policy targets. Since 2017, the indicator-based assessment component of the TERM report has been published as a separate briefing.

The most recent TERM report assesses progress towards reducing greenhouse gas emissions, and finds that although vehicle efficiency is improving, growth in travel means that

<sup>156</sup> Source of the illustration: IFSTTAR

total transport-related greenhouse gas emissions continue to rise. However, while TERM assesses progress on environmental outcomes including greenhouse gas emissions, air quality and noise, other important health outcomes such as road traffic injury and physical activity are still missing.

While TERM provides a promising example of transport and environment system monitoring for Europe, low- and middle-income countries require different monitoring approaches due to their differing levels of resources available for data collection. One possible solution would be to implement a standard set of surveys collecting information on a limited set of the most key factors, e.g. modal split, pedestrian/cycle injuries, and other health risks and outcomes, for statistically significant samples in key urban areas and/ or for different population groups. This would help monitor key transport and health links, and enrich analysis of actual and expected impacts of policy changes on public health and livability.

## 6.5 Is autonomous driving the next big thing? (and will it be private or public?)

Artificial Intelligence (AI), the Internet of Things (IoT), and big data analytics are already used as tools in automating transport systems. Connected Intelligent Transport Systems, carsharing, e-ticketing systems, e-tolling, autonomous vehicles and smart mobility are currently the concepts that are being discussed the most by UNECE countries as Intelligent Transport Systems of the future.

The global trend is the use of automated control systems for driving, traffic and supervisory actions:

- On-board telematics-control of components and systems of vehicles (parking assistance, lane maintenance, prevention of collision with vehicles ahead);
- Road infrastructure telematics - information and navigation functions, automated traffic control system (ATCS);
- Automated control of compliance with traffic regulations - traffic cameras in place to capture traffic regulations violations and send them to control (supervisory) bodies;
- Telematics of economic entities — management of passenger and cargo transportation (optimisation of timetables, loading, etc.)



**Illustration. Switzerland's first experimental real scale driverless bus will run until 2019 in the city of Sion (Valais region)<sup>157</sup>**

The term CAV (connected autonomous vehicles) refers to different issues. A vehicle can be automated to a varying degree and/or connected to different extents. The broad definition of these two components is Cooperative Intelligent Transport Systems (C-ITS), with CV referring to vehicles with increased

connectivity which makes them communicate with their environment (including infrastructure

<sup>157</sup> Source: *Global Geneva*, Peter Hulm, Nov. 2017. Swiss Post, the city of Sion and Valais authorities have announced that the 16-month experiment of running two PostBus driverless buses (with yellow-teeshirted attendants) through the pedestrian quarter of the Valais capital will continue "at least until the end of 2018". The 11-seaters are free and use the livery of Swiss Post buses. So far, they have carried 60,000 passengers, and survey found over half (51%) had few qualms about travelling on the minibuses. This compares with a 2014 study that found safety concerns bothered 87% of people questioned in China, 78% in the United States, 77% in India and 75% in Japan

and other vehicles). This can provide information about road, traffic and weather conditions, routing parameters as well as ensuring a wide range of connectivity services.

Among the most pressing issues linked with smart mobility is information control. In a world where mobile devices of communication and data exchange have become widespread, traditional IT methods of computer networks protection are no longer sufficient, particularly with regard to the issues of IT public transport security.

There is a growing need to respond to cyber threats. To that end, it is necessary to develop and enforce rules of guaranteed network equipment cyber security, to resort to artificial intelligence technologies, self-learning systems and automatic data processing means. At the same time, any innovations and technologies are introduced better and quicker through joint efforts involving developers, operators, regulators and authorities. Contemporary disruptions also question privacy rights, with very different policies and norms depending on country and regional legal systems.

**Table. Example of an autonomous mobility structure**

External machine vision	Internal machine vision	Cooperative ITS	Digital road model; V2I; I2V
<ul style="list-style-type: none"> <li>■ Active emitters Radar, lidar</li> <li>■ Stereoscopic devices</li> <li>■ Combined</li> </ul>	<ul style="list-style-type: none"> <li>■ Transport psychology</li> <li>■ Car-cabin internal status</li> <li>■ Emergency situation decision-making system</li> </ul>	<div style="background-color: #c8e6c9; padding: 5px;"> <b>Multiservice platform</b> <ul style="list-style-type: none"> <li>■ IoT; LTE-V</li> <li>■ DSRC; G5</li> </ul> </div>	<div style="background-color: #c8e6c9; padding: 5px;"> <b>High-precision map; Aggregated data on the transport situation; Decision-making system (macrolevel)</b> </div>

The development of autonomous vehicles will have an impact on responsibility and insurance policies, as it changes the organisation of traffic patterns. The influence on road safety will be an important criterion to evaluate. The influence on traffic fluidity will be another. Although less traffic congestion could derive from traffic optimization, the actual size of an autonomous vehicle, whatever the source of energy it uses, is not different from a traditional one, hence the portion of road it needs to move on.



One additional innovation that is currently in test mode is the combination of autonomous driving and self-charging vehicles in energy systems integrated within road infrastructures.

**Illustration: experimental energy road: the Versailles-Satory charging infrastructure for Dynamic Wireless Power Transfer systems testing.**<sup>158</sup>

<sup>158</sup> Source: Stéphane Laporte, Gérard Coquery, Virginie Deniau. *32nd Electric Vehicle Symposium (EVS32) Lyon, France, May 19 - 22, 2019. The Versailles-Satory charging infrastructure for Dynamic Wireless Power Transfer systems testing*

To conclude on this chapter and the perspectives of combined electro mobility and autonomous vehicles, the approach to long term perspectives should be tackling all dimensions, that is ground, air (drones) but also water. Amsterdam AMS has been a forerunner in researching how automated boats could serve a series of purposes in cities ranging from



passenger mobility to waste management and temporary public space organisation (temporary bridges). As of 2019, the main practical uses though are focusing on using drone-boats to survey water and canal embankments.

**Illustration. The prototyping of “roboats” experiment in Amsterdam, a global cooperation <sup>159</sup>**

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<sup>159</sup> Source: Amsterdam Institute for Metropolitan Solutions (AMS), in cooperation with MIT





## **Chapter 7.**

# **Methodology of sustainable urban transport planning: making the case for a comprehensive approach**

## Chapter 7. Methodology of sustainable urban transport planning: making the case for a comprehensive approach

### 7.1 Towards a sustainable transport and urban planning

The diversity in the levels of development represents “a challenge to UNECE, as it must respond to the expectations of its different members. However, it is also an advantage, as it encourages the sharing of experience and knowledge, as well as a guarantee of financial and technical aid to countries in need”<sup>160</sup>.

At the same time all regions, all countries, all cities, all stakeholders, are confronted to converging mounting similar challenges such as urban growth and urbanization (notwithstanding regions suffering from demographic losses), traffic congestion, a global call and subsequent commitments to reduce CO2 emissions and tackle global warming, low physical activity due to the mass use of cars, technological changes and disruptions and so on. In spite of the differences between countries and cities of the region there may be common methodological approaches which may be considered as a base for decision-making process at local, regional and national levels to improve urban transport systems sustainability.

Addressing the issue of sustainable transport and urban planning in 2019 means bridging the gaps and connecting spheres of policy-making (policy development, implementation and enforcement), finance, professional duties, standards, that have been so far largely disconnected.

Enrique Peñaloza, one of the ideologists of the New Urbanism, contends: “It is not motorways that make a city more civilised, but it is when a child can ride almost anywhere on a tricycle in an easy and safe manner that it becomes more civilised”<sup>161</sup>. This statement, however, can be complemented by saying that such a city would be a convenient place for all citizens, including even those who cannot abandon their private cars. This “tomorrow city” can’t be associated with high CO2 emission, with suffering from long-term health damage due to hours spent in congestion or in stressing, congested, environments, with poor air quality, with spending hours in transportation to get a job and keep it. All that is the key condition for ensuring of “quality of life” in the city. As is mentioned above, this can only be achieved through the introduction of “sustainable urban and transport planning” principles and approaches.

Practice has shown that attempts to secure sustainability and efficiency for urban transport systems without due regard for urban planning aspects, with a focus on supply of transport system`s capacity only proves to be a failure. In principle people`s mobility needs are defined by the level of objects` accessibility (working places, services, social infrastructure, other peoples and so on) in the urban environment.

In GIZ Manual “Planning Dense and Human Scale Cities”<sup>162</sup> it’s pointed out that ensuring the sustainability of the urban transport system is achieved through implementing the principle of three levels of decisions defined by the words “avoid-shift-improve”. This approach entails the following allocation of actions under existing urban policies and national authorities:

- **“avoid”** - achieve decreased generation of transport demand, reduced travel distances and vehicle mileage (“ensuring proximity”), an environment established for demand to be reallocated between different modes of transport, rationalising the traffic conditions for vehicles by implementing **measures of urban planning and transport policies, mechanisms of improved land use and traffic management measures** (Figure 7.1 illustrates the interaction between land use and traffic planning);

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<sup>160</sup> Source: UNECE

<sup>161</sup> Enrique Penalosa. *Urban Transport and Urban Development: a Different Model*. Center for Latin American Studies, Universities of Californai, Berkeley, April 2002.

<sup>162</sup> Manual “Planning Dense and Human Scale Cities”, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, February, 2014.

- **“shift”** - ensure that transport demand is rerouted to safer modes of urban transport and travel (“active modes”) **through mobility management tools and measures (transport policy)**;
- **“improve”** - step up the safety and efficiency of vehicles, fuels used, transport technologies **through tools and measures of technical and transport policies.**

The list of **level 1 – avoid** measures is known to incorporate:

**a) in urban planning:**

- Achieving institutional, legislative and regulatory integration for urban and transport-planning issues (in particular, a single body must be established within the city administration that would be in charge of urban planning and transport);
- Assessing the impact that the construction and reconstruction of all housing, social, cultural and industrial buildings and facilities have on the urban transport system; ensure that enough capacity of the transport system, required by the new housing, reached, according to the public transport quality standards, before the new housing is placed into service;
- Support for affordable housing projects in the central parts of cities (with a view to curb the flow of city-centre-bound trips);
- Housing areas must be arranged in conformity with the “mixed use” concept;
- Planning dense, but limited-in-height built-up areas to meet the physical and psychological expectations of people; ensuring pedestrian accessibility to the main places of attraction and establishing an enabling environment for priority use of other active modes of travel;
- Promoting the creation of urban local (district) centres, urban public spaces and “calming areas”;
- Designing traffic-free residential areas.

**b) managing the use of urban areas from the perspective of transport service:**

- Ensuring that the built-up areas around the urban mass transit stations generate profits without losses for the operation of transport facilities;
- Using this to stimulate the establishment of trade and service companies in the areas of urban transport hubs as well as providing for offices spaces near urban mass transit stations;
- Arrange socially important objects such as local authority and social service offices, medical clinics, libraries, collages in close vicinity of main high-frequency public transport stops so as to make them accessible for all by public transport;
- Ensure transit-oriented development, i.e. concentration of high-capacity housing around the high-frequency route stops;
- Designing districts with a low density of buildings in such a way as to locate them within accessible cycling distance from urban mass transit systems;
- Allocating spaces and establishing the necessary environment for bicycle parking in the areas of urban mass transit systems.

**c) infrastructure improvement:**

- Ensuring the connectivity of urban areas and cutting down the excess mileage resultant from detours made of necessity;

- Improving road traffic management including through prioritising pedestrian, cycling and PT traffic (especially at difficult junctions and by putting in place a dedicated infrastructure for the transport modes in question).

**d) supporting solutions:**

- Establishing agencies within urban administrations that would be in charge of the implementation of integrated urban and transport planning policies, encouraging the establishment of associations of public transport operators, associations of PT users, etc.;
- Designing and rolling out sustainable urban mobility plans, ensuring that they are extensively discussed with their implementation monitored;
- Integration of transport into climate change plans and programmes along with environmental plans and programmes;
- Encouraging the use of local products thereby mitigating the need for transportation;
- Ensuring recreational opportunities at the local level and decreasing the number of trips made to enjoy such opportunities elsewhere;
- Encouraging employers to introduce flexible schedules and teleworking.

The list of **level 2 - shift** measures is known to incorporate:

**a) improving the urban public passenger transport system:**

- Designing and implementing standards of public transport services quality; carry out of permanent monitoring of fulfilment of these standards` requirements by means of automatic sensors and electronic systems;
- Initiating transport demand and public passenger transport surveys;
- Provide multimodal optimisation of the route network of urban public passenger transport (see section 3), ensuring fulfilment of quality standards requirements for every citizen with less possible direct costs and externalities (accidents, pollution and noise, time spent). Use the most efficient transport modes: tramway and light rail, urban railway, dedicated bus lanes. Use trunk-feeder network with high-frequency arterial routes and local coverage routes;
- A simple and easy-to-understand ticketing system to be introduced for users, socially fair tariffs to be provided for urban transport. Implement fare systems in line with passengers' demand, promote all the fares based on time, independently from transport modes and transfers. Provide palpable discounts for long-term (30 to 365 days) tickets so as to promote permanent public transport users and suppress fare evasion;
- Integrated (involving all transport modes) schedules to be introduced;
- Public passenger transport operators must create user-friendly websites;
- Ensuring an environment wherein developers of “smart phones apps” will have access to information on the operation of public passenger transport and traffic conditions on the road network;
- Ensuring convenient transfers: shortest possible walking distances, all stairs duplicated with micro-ramps or lifts/escalators;
- Implementing ride-sharing, car-sharing, car-pooling programmes and their integration into the urban public passenger transport system along with traditional taxi integrators;
- Initiating advertising and publicity campaigns to promote the use of Public transport;



- Implementing, the concept of “Mobility as a Service” (MaaS) through the use of modern information and communication technologies;
- Introduction of unified urban passenger transport management mechanisms, including tendering procedures, promotion of transport associations, establishment of urban monitoring centres, and multimodal transport management, implementation of effective mechanisms for financing municipal passenger transport, etc;
- Ensure public transport operators efficiency by means of gross contracts (all the fares are collected by the city; the city pays to the operator for mileage and punctuality independent of passenger travelled). Create conditions for investments in public transport, (in particular by the use of PPP).

**b) promoting walking and cycling:**

- Designing and adopting concepts and plans to promote walking and cycling at the municipal level;
- Establishing a position to be filled by a person responsible for promotion of cycling and walking within the city administration;
- Developing and adopting recommendations to govern the design of pedestrian and bicycle infrastructure under the concept of “complete streets”;
- Establishing a full-fledged urban bicycle network, including dedicated lanes for cycling traffic, cycling highways, bicycle parking, etc;
- Ensuring a “barrier-free” pedestrian environment, pedestrian areas and public pedestrian spaces;
- Introducing modern methods and means to organise and maintain a safe environment for walking and cycling together with systems which prioritise the traffic of cyclists in road traffic;
- Initiating advertising and publicity campaigns to promote the use of bicycles and other means of active mobility;
- Encouraging companies which incentivise their employees to cycle their way to work.

**c) management of the use of various modes of urban transport:**

- Imposing restrictions on the traffic of motor vehicles (bans on the traffic of certain categories of vehicles, introduction of fees to be paid to enter certain areas, “low emission zones – LEZ”, toll urban highways, etc.);
- Creating freight logistics centres;
- Agreements with enterprises/companies on providing employees with monthly public transport passes, creation of corporate parking spaces;
- Promoting daily work trips by bicycles or public transport;
- Promoting the economic benefits of abandoning private cars as well as the benefits of active mobility or shared use of vehicles, stimulating various solutions aimed at swaying individuals in favour of renouncing private cars voluntarily;
- Redistribution of available road space and its capacity in favour of non-motorised traffic users and public passenger transport.

**d) parking management (parking policy):**

- Formulating parking rules (requirements) (designation of paid parking areas, payment conditions, types of parking spaces and parking lots, enforcement measures, etc.);

- Identifying the “parking capacity” of urban areas and establishing parking fees (striking a balance in the supply of parking spaces and the parking fees, ensuring that 15% of parking spaces are not occupied most of the day);
- Providing information on parking spaces and free parking spaces available;
- Introducing parking time restrictions;
- Enforcement of parking rules (parking police, tow trucks, fines).

The list of **level 3** measures is known to incorporate:

**a) promoting the production and use of clean vehicles and motor fuels/energy sources:**

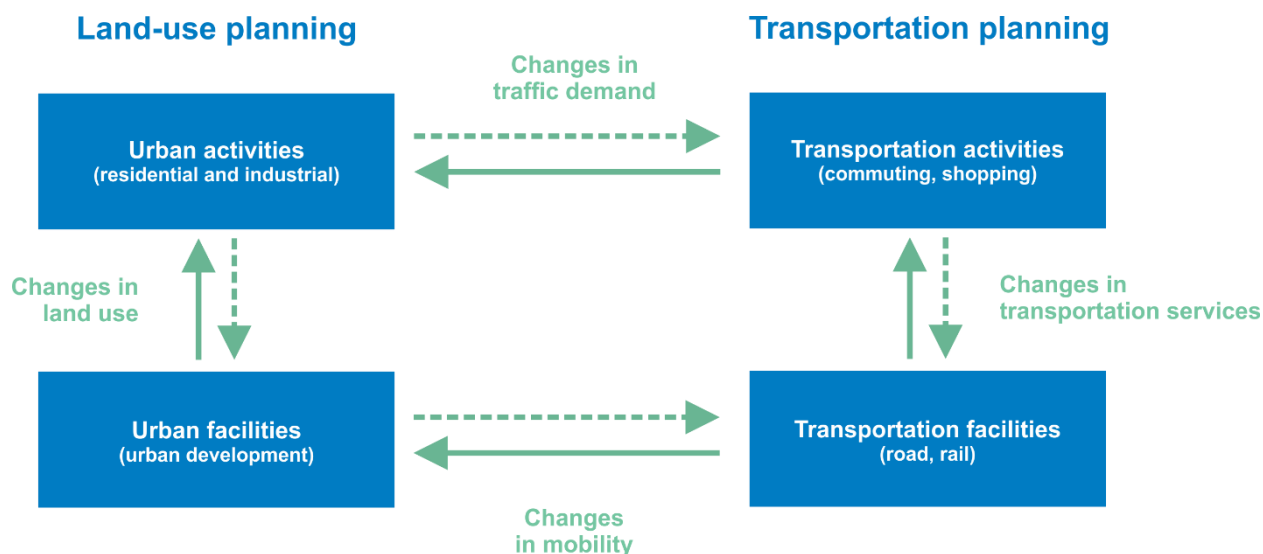
- Adoption of modern requirements in respect of newly manufactured and imported cars that would extend to their emission levels, energy efficiency and external noise, limiting the import of “old” cars;
- Adoption of modern requirements to produced and imported motor fuels while also introducing a mechanism to control the quality of motor fuels on sale and establishing liability for fuel infrastructure operators;
- Designing and introducing legal and institutional arrangements aimed at the renewal of the fleet of vehicles currently in use through “scrappage schemes” and retrofitting certain categories of vehicles in use;
- Establishing effective procedures for maintenance of vehicles and monitoring of their technical state in operation;
- Introducing “low emission zones” in cities;
- Considering feebates to owners with the aim to urge them to transition to more energy efficient and/or eco-friendly vehicles;
- Promoting “clean fuels”;
- Ensuring the right infrastructure for “clean fuels”/charging infrastructure for e-vehicles;
- Introduction of taxation mechanisms in order to encourage the purchase and use of the most “clean” types of vehicles;
- Ensuring that environmentally friendly and economical rolling stock is procured for public needs (municipal transport).

**b) improving the current transport technologies and traffic conditions:**

- Putting a system in place that would communicate operational (on-time) information to road users on traffic conditions, traffic congestion, availability of parking lots, PT timetables showing the arrival time of vehicles, etc.
- Differentiation of speed limits within cities by urban road categories (with different speed limits in residential areas and general roads), better monitoring of compliance with these restrictions and imposing penalties for violations;
- Improving road traffic management including through prioritising pedestrian, cycling and PT traffic (especially at difficult junctions and by putting in place a dedicated infrastructure for the transport modes in question).
- Improved traffic management on the urban road network, better management of passenger and freight transportation via modern means of automation, telematics and transport navigation.

Figure 7.1 shows the pattern of between land use and traffic planning.

Figure 7.1. Relation between land use and traffic planning<sup>163</sup>



Bringing about changes in our cities calls for ideas and strategies, but of higher importance for any city is the practical experience of turning an idea into an action plan. There is no doubt that sustainable transport and urban planning can be implemented, in varying proportions, depending on the particular urban development situation and the prevailing land-use patterns:

**Cities with an established built environment** first of all must seek to adapt and retrofit their transport systems accordingly with a view to achieve maximum **urban-area accessibility** for public transport, non-motorised modes of transport and, last of all, private vehicles. In this instance, the existing transport system should be re-designed from “auto-oriented” to “mass-transit-oriented” by cutting down the growing transport demand through new construction activities or “mixed-use” construction and launching mass transit systems according to the principles listed in **Chapters 2 and 3** with a focus on supporting the development of electric transport. The principles of mixed use should also extend to infill projects, refurbishment of individual residential buildings, arrangement of social amenities, trade and cultural sites and the construction of business centres. Level 2 and 3 measures and decisions can be fully implemented in this context.

The implementation of the housing principles set out in Chapter 2 is best-suited to **newly designed or re-designed cities and urban areas**. In this case transport demand may be optimised through the reduction of excessive mobility, bringing points of generation and absorption of transport demand closer to each other and implementing the principles of “mixed-use” urban planning. Level 1, 2 and 3 measures and decisions can be fully implemented in this context.

The multifaceted nature of the task to create “liveable” cities determines the priority not only coordination between land-use and transport policies but also development of proper strategic planning documents focused primarily on improving people’s quality of life and ensuring the availability of various material and spiritual benefits, social services, access to workplaces and interaction with others. Development of such strategic documents has to make it possible to seek a balance between transport and urban planning solutions, enhance transport accessibility, ensure the desired speed and comfort of public transport, improve road safety and mitigate the adverse impact of transport on the environment and public health.

<sup>163</sup> [http://www.iatss.or.jp/common/pdf/en/publication/commemorative-publication/iatss40\\_theory\\_02.pdf](http://www.iatss.or.jp/common/pdf/en/publication/commemorative-publication/iatss40_theory_02.pdf), Traffic and Safety Sciences: Interdisciplinary Wisdom of IATSS Transportation and land use. The International Association of Traffic and Safety Sciences, Akinori Morimoto. Professor, Faculty of Science and Engineering, Waseda University, 2015.

Properly defined current challenges and objectives in the field of urban transport sustainability makes it possible to select the transport policy instruments which may be used by integrated land-use and transport policy to address these challenges as well as packages of appropriate measures and activities to be taken which may to be included strategic planning documents. Some examples of possible objectives and indicators to measure their progress (indicators to assess the process and the outcomes) which may be used to pinpoint existing problems in the area in question are given in Figure 7.2.

**Figure 7.2. Examples of possible targets and indicators used in the development of integrated urban and transport planning policy documents**

	Theme	Indicator
Environmental indicators	Global climate change	Greenhouse gases from transport
	Air pollution	Acidifying gases from transport Volatile organic compounds from transport
	Consumption of natural resources	Consumption of mineral oil products, transport Land coverage Need for additional new construction
Social indicators	Health	Exposure to PM from transport in the living environment Exposure to NO <sub>2</sub> from transport in the living environment Exposure to traffic noise Traffic deaths Traffic injuries
	Equity	Justice of distribution of economic benefits Justice of exposure to PM Justice of exposure to NO <sub>2</sub> Justice of exposure to noise Segregation
	Opportunities	Housing standard Vitality of city centre Vitality of surrounding region Productivity gain from land use
	Accessibility and traffic	Total time spent in traffic Level of service of public transport and slow modes Accessibility to city centre Accessibility to services Accessibility to open space
Economic indicators	Total net benefit from transport	Transport investment costs Transport user benefits Transport operator benefits Government benefits from Transport Transport external accident costs Transport external emissions costs Transport external greenhouse gases costs Transport external noise costs

Analysis has **shown** that there may be used different political instruments and practical measures which can be generally grouped into 6 units: land-use activities; infrastructure development; transport and traffic management; information support; measures to change attitudes and transport behavior; pricing policy. The effectiveness of different political instruments, depending on the selected objectives, is presented further in regard to the central parts of cities with an established built-up environment already in place and little room for reconstruction in order to change land-use patterns with construction works under way tending to be oriented at building individual commercial facilities or infill elite projects<sup>164</sup>.

**Figure 7.3. The impact of policy instruments in city centres**

<sup>164</sup> Developing sustainable urban land use and transport strategies, Anthony D. May, Professor of Transport Engineering, University of Leeds, UK, 2005.



Contribution of policy instruments in City Centres								
	Efficiency	Environment	Liveability	Safety	Health	Equity	Economy	Future generations
Land use	*	*	**		*		***	***
Infrastructure	**	**	**	**			**	*
Management	***	***	***	***	*	***	*	**
Information	**	*		*		*		*
Attitudes	*	**	*	*	**			*
Pricing	*****	***	*	**	**	**	**	*****

Key: \* Minor contribution \*\*\*\*\* Major contribution

The effectiveness of the instruments in question depending on the selected objectives is presented in Figure 7.4 for “sleeping areas” where there is much greater room for changing land-use patterns, new construction works and reconstruction of existing buildings.

**Figure 7.4. The impact of political instruments in “sleeping areas”**

Contribution of policy instruments in Inner Suburbs								
	Efficiency	Environment	Liveability	Safety	Health	Equity	Economy	Future generations
Land use	**	**	***		**	*	****	****
Infrastructure	***	***	***	***	*	**	****	**
Management	****	***	***	****	***	***	**	**
Information	***	**	*	**	*	*		*
Attitudes	***	**	*	*	**			*
Pricing	****	**	*	*	**	**	*	****

Key: \* Minor contribution \*\*\*\*\* Major contribution

Problems associated with the rapid growth of territories are especially relevant in relation to the suburbs. For that reason, the integration of transport planning and transport policy with land-use and urban development policies is of the greatest importance. The effectiveness of the instruments in question is presented in Figure 7.5 for the abovementioned environment.

**Figure 7.5. The impact of political instruments in outer suburbs**

Contribution of policy instruments in Outer Suburbs								
	Efficiency	Environment	Liveability	Safety	Health	Equity	Economy	Future generations
Land use	****	****	****	**	***	**	***	*****
Infrastructure	**	**	**	**			***	**
Management	***	**	***	**	**	***	**	**
Information	***	**	*	**	*	*		**
Attitudes	****	***	*	*	**			**
Pricing	***	**	*	*	*	**	*	****

Key: \* Minor contribution \*\*\*\*\* Major contribution

The situation in relatively smaller urban areas is of particular interest (Fig. 7.6).

**Figure 7.6. The impact of policy instruments in smaller urban areas**

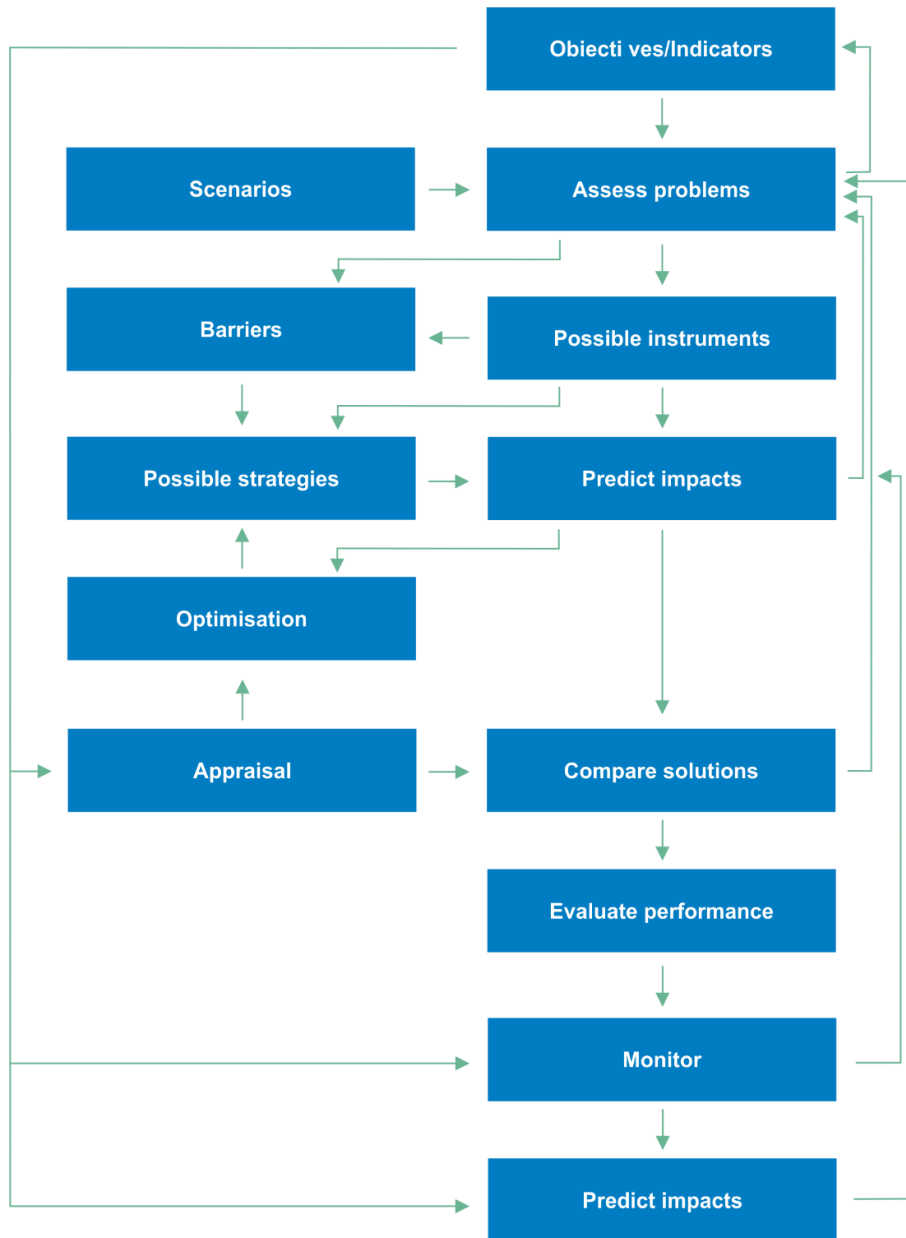
Contribution of policy instruments in Smaller Urban Areas								
	Efficiency	Environment	Liveability	Safety	Health	Equity	Economy	Future generations
Land use	****	***	***	*	**	**	***	*****
Infrastructure	*	*	*	*			**	*
Management	****	***	**	***	**	**	**	**
Information	***	**	*	**	*	*		*
Attitudes	****	***	*	*	**			*
Pricing	**	*		*		*		***

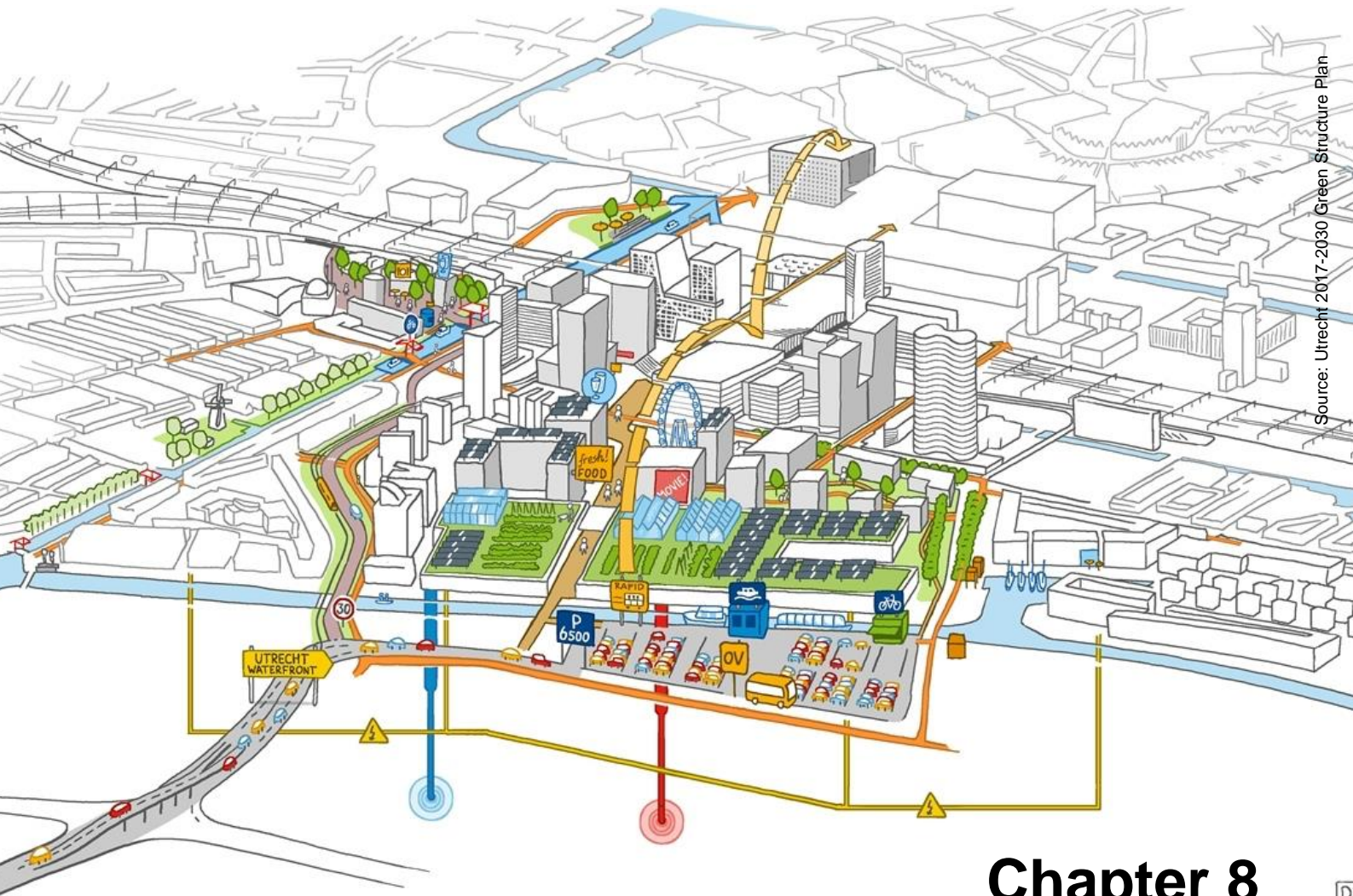
Key: \* Minor contribution \*\*\*\*\* Major contribution

With regard to the need for a practical approach to decision-making in integrated urban and transport planning, the significance of an agreed process to implement it must be underscored. A common logical structure of such an approach should incorporate the following elements (Fig. 7.7):

- clearly defined objectives and measures to assess the progress;
- problems and barriers that currently hamper the achievement of the goals must be identified and assessed and potential problems and barriers for the future must be predicted;
- a strategy to achieve the goals must be designed with tools and activities selected to overcome the identified problems;
- the outcomes of the Strategy must be forecast and tools selected by relying on land-use and transport patterns;
- ways must be found to improve the tools, activities and the Strategy itself with the most efficient scenarios chosen to that end;
- implementation of the selected tools, activities and the Strategy as a whole;
- monitoring and evaluating the effectiveness of the progress made and the results achieved;
- assessing whether the original goals and objectives have been achieved;
- optimising plans and solutions and improving forecasts.

**Figure 7.7. The logical structure behind the practical approach to decision-making**





Source: Utrecht 2017-2030 Green Structure Plan

## Chapter 8 Conclusion & Recommendations



## Chapter 8. Conclusion & Recommendations



Over recent decades city governments, municipalities, local agencies and urban transport professionals face significant challenges related to transition from a primarily car-based mobility towards low carbon mobility based on walking, cycling, integrated public transportation and collective passenger transport. Growth of transport demand in car-oriented urban economy leads to increase in transport congestions, emission of harmful substances and climate gases, noise, road accidents. Wide use of cars promotes sedentary life style.

Commuting in growingly interconnected urban regions takes time. For many, mobility takes a heavy toll on household's resources and health. As pressure on quality of life is mounting, the temptation for short term improvements is strong but this cannot be done at the expense of long term sustainable planning perspective for their cities.

To resist these challenges city authorities should offer users better and more sustainable transport and mobility solutions to mitigate the negative impacts of transport on citizens' health and well-being, environment and climate. They need also to balance the desire for short-term improvements with the ambition to develop a strategic and sustainable planning perspective for their cities. In many cases, these challenges need to be approached under severe financial constraints due to the present economic difficulties and strained public budgets.

The present report provides a comprehensive overview and forecasts of global trends and challenges in the field of urban transport and mobility. It also highlights how local mobility is embedded in a series of global socio-economic issues.

Improvement and coordination of spatial and transport planning has to be considered as one from the key conditions to realize sustainable urban mobility principles. "Avoid-Shift-Improve (A-S-I)" approach has to be the base for comprehensive and coordinated spatial and transport planning with the accessibility assuring as a core at the first stage ("Avoid"). Finding a right balance between three basic parameters of the urban environment – accessibility, proximity and mobility - is a main task of urban and transport planners. Compact, dense and transit-oriented development of cities and mixed land use reduce the need to travel and gives the possibility to avoid/reduce "hypermobility" which may be resulted from urbanization growth and urban sprawl.

"Shifting" mobility to the use of more "environmentally clean" and "healthy" modes of transportation – public transport, active mobility - in combination with implementation of new technologies "improving" performances of urban transport system (shared mobility, e-mobility, ITS, automated driving, use of alternative fuels and sources of energy and others) allows to further improve the urban transport systems sustainability.

In such systems the effective public transport has to be a core element, a vital part of well-functioned “livable city”. The key goal of public transport planning is to achieve certain level of PT services quality expressed in special standards with target values oriented on a passenger satisfaction. Transport planners should choose the more effective route network which meet the requirements of quality standard. Development of public electric transport– most environmentally friendly transport with high transit capacity - should be specially attended. It is also important to bear in mind special issues of PT financing including ensuring proper electricity rates, implementation of green financing mechanism etc.

Last decades issues related to active mobility development have become an important direction of ensuring of urban transport systems sustainability and at the same time an important means for people`s health improvement. In particular, special attention should be focusing on cycling infrastructure development, instruments promoting active mobility in urban environments, raising awareness of the role of walking and cycling, different cycling initiatives.

Sustainable urban mobility depends on sustainable technological solutions to a greater extent than ever, be it about shared mobility, electro-mobility or intelligent transport systems including artificial intelligence and big data. This provides a wealth of opportunities, as embodied in new concepts such as mobility as a service (MaaS). The ever-growing importance of technology and data in mobility systems is weighing on the ability of cities to drive their future. The management of sustainable urban mobility also depends on industry shifts. The future of the car industry, a provider of millions of jobs in many regions such as in Europe, will influence mobility systems.

Development of new technologies changing the face of modern urban transportation gives the possibility to insist that methods of planning need to change and plans alone are not enough.

The ability to understand ongoing changes, profit by them and combine various inputs, is a critically important skill in times of many disruptions. It`s possible to identify a dozen sets of issues that decision makers need to take into account to build transformational policies:

- 1) The rise of shared, free-floating and other micro-mobility solutions;
- 2) The continuous upgrade or road safety including active modes;
- 3) The development of citizen's participation and communication to build consensus;
- 4) The consequences of automated driving and connected city of mobility flows and public space management;
- 5) The acceleration of alternative fuels, vehicles and green infrastructure deployment;
- 6) The risks of segregated urban development: cities have to be inclusive and accessible for all;
- 7) The need for strategic planning for efficient urban freight logistics;
- 8) The ability to apprehend emerging mobility solutions and use them to reinforce long term planning;
- 9) The assessment and reaping of the health benefits of walking and cycling;
- 10) The development of smart solutions to address mobility challenges in rural areas, in small and medium cities, as well as in suburban areas;
- 11) The capture of changing public opinion on air quality issues to enforce new access regulations;
- 12) The opportunities to leverage green investments through large scale and integrated transportation infrastructure projects at metropolitan and regional scales.

**Key messages for the future to politicians, mayors and other decision-makers working on issues related to transport and urban planning at the city level:**

- ✓ Sustainable urban transport and mobility are key in achieving the 2030 Agenda and effective urban transport systems can support climate change mitigation and reduce CO2 emissions;
- ✓ The way to make transport systems more resilient requires the adoption and further implementation of comprehensive approach based on clearly defined objectives. It should include measures in spheres of transport, economic and urban development policies, as well

as social cohesion. The good path to solve this task is to promote urban mobility planning documents provided principles of sustainability, affordability, quality of services and safety;

- ✓ Decision-making processes need to be designed within complex and integrated context, addressing right goals which fulfilment must be monitored with the use of different information and telecommunication solutions;
- ✓ People have to be the main focus of sustainable urban mobility plans and projects, with an emphasis on safety, reliability, affordability and comfort of public transportation service, the reduction of health risks, the promotion of liveability for all;
- ✓ “Avoid/Reduce – Shift / Maintain – Improve” approach has to be implemented to achieve objectives of transport systems sustainability. Avoiding “hypermobility” by promoting more compact urban development models, Shifting to cleaner and healthier transport modes and Improving the efficiency of vehicles and technologies;
- ✓ Land use and demand management need greater emphasis. The role of transport and land use planning integration is extremely crucial;
- ✓ Public transport is a key element of a “liveable city” and public transport improvements have to be a dominant element of city strategy. Public transport priority means that public transport projects are financed in the first place, and any realized transport project has to give more benefits for passengers than for car owners;
- ✓ Planning with the engagement of stakeholders in the process of decision-making processes through a transparent and participatory approach. All normative values of indicators for PT should be stated as passenger-vision and fixed as “service quality standards”. To make public transport more attractive the more effective route network should be chosen and priority of public transport traffic has to be ensured;
- ✓ Active mobility is a core element of healthy cities. Walking and cycling need to be supported not only in urban cores but at much larger scales, in combination with other modes and especially public transportation. Cities need to pay a particular attention to develop user-friendly intermodal hubs and to provide amenities supporting the development of cycling and walking. Initiatives such as WHO healthy cities network should pay more attention to transportation and mobility as key factors;
- ✓ Cities are witnessing the rise of a new generation of Intelligent Transport Systems, which profit from financial and technological opportunities offered by digitalization. UNECE should to review the ITS 2012 report and make a strong case on using ITS to drive sustainable and inclusive mobility systems;
- ✓ Decision-makers need to develop new skills to build plans and make the best out of current technological and social disruptions; they also need to work through partnerships to implement comprehensive, cross-sectoral mobility policies;
- ✓ Urban transportation systems are growingly complex. Along with existing public and private, collective and individual mobility systems, shared mobility and more recently, autonomous mobility, question the organisation of public space in cities and raise the need for more transparent decision-making processes;
- ✓ Along with people, freight is the other dimension of sustainable urban transport and mobility. Managing urban logistics is vital to build and implement comprehensive climate neutral mobility policies while taking care of public space and quality of life for all;
- ✓ The replacement of polluting bus fleets, the promotion of electro-mobility, the development of modern trams and intermodal hubs are relevant solutions for more sustainable transport, provided this goes with land management policies avoiding urban sprawl and inclusive eco-density;
- ✓ The role of national governments is to ensure legal frameworks for development and implementation of sustainable urban mobility solutions at local level.

This Handbook addresses one of the most pressing challenges of our time – how to foster sustainable, livable and harmonious cities.

If cities will be able to use this guide to create their own vision and road map towards a sustainable future, the Handbook would have accomplished its mission.





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## ANNEX



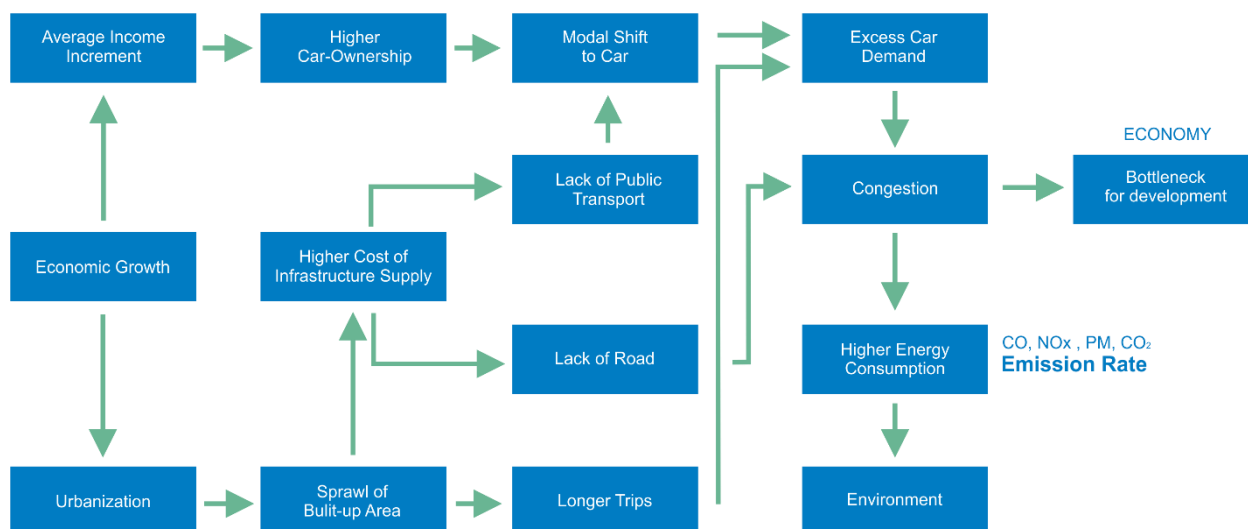
## Annexes to Chapter 1

### Annex 1.1 Urban demographics (% of total pop.) in UNECE countries (1950-2050)<sup>165</sup>

Region, subregion, country or area	1950	1970	1990	2000	2010	2015	2020	2030	2050
Albania	20,5	<b>31,7</b>	36,4	41,7	52,2	57,4	<b>62,1</b>	69,5	<b>78,2</b>
Armenia	40,3	<b>59,9</b>	67,4	64,7	63,4	63,1	<b>63,3</b>	65,5	<b>74,3</b>
Austria	63,6	<b>65,3</b>	63,0	60,2	57,4	57,7	<b>58,7</b>	61,8	<b>70,9</b>
Azerbaijan	45,7	<b>50,0</b>	53,7	51,4	53,4	54,7	<b>56,4</b>	60,8	<b>71,0</b>
Belarus	26,2	<b>44,0</b>	66,0	70,0	74,7	77,2	<b>79,5</b>	83,3	<b>88,3</b>
Belgium	91,5	<b>93,8</b>	96,4	97,1	97,7	97,9	<b>98,1</b>	98,4	<b>98,9</b>
Bulgaria	27,6	<b>52,3</b>	66,4	68,9	72,3	74,0	<b>75,7</b>	79,0	<b>84,9</b>
Croatia	22,3	<b>40,2</b>	51,0	53,4	55,2	56,2	<b>57,6</b>	61,5	<b>71,3</b>
Cyprus	28,4	<b>40,8</b>	66,8	68,6	67,6	66,9	<b>66,8</b>	68,1	<b>74,5</b>
Czechia	54,2	<b>64,4</b>	75,2	74,0	73,3	73,5	<b>74,1</b>	76,1	<b>82,2</b>
Denmark	68,0	<b>79,7</b>	84,8	85,1	86,8	87,5	<b>88,1</b>	89,4	<b>92,3</b>
Estonia	49,7	<b>64,9</b>	71,2	69,4	68,1	68,4	<b>69,2</b>	71,4	<b>77,3</b>
Finland	43,0	<b>63,7</b>	79,4	82,2	83,8	85,2	<b>85,5</b>	86,6	<b>90,0</b>
France	55,2	<b>71,1</b>	74,1	75,9	78,4	79,7	<b>81,0</b>	83,6	<b>88,3</b>
Georgia	36,9	<b>48,0</b>	55,0	52,6	55,5	57,4	<b>59,5</b>	63,9	<b>73,2</b>
Germany	67,9	<b>72,3</b>	73,1	75,0	77,0	77,2	<b>77,5</b>	78,9	<b>84,3</b>
Greece	52,2	<b>64,2</b>	71,5	72,7	76,3	78,0	<b>79,7</b>	82,8	<b>87,7</b>
Hungary	53,0	<b>60,1</b>	65,8	64,6	68,9	70,5	<b>71,9</b>	75,1	<b>81,8</b>
Ireland	40,1	<b>51,3</b>	56,9	59,2	61,5	62,5	<b>63,7</b>	66,8	<b>75,1</b>
Italy	54,1	<b>64,3</b>	66,7	67,2	68,3	69,6	<b>71,0</b>	74,3	<b>81,1</b>
Kazakhstan	36,4	<b>50,2</b>	56,3	56,1	56,8	57,2	<b>57,7</b>	60,0	<b>69,1</b>
Kyrgyzstan	26,5	<b>37,5</b>	37,8	35,3	35,3	35,8	<b>36,9</b>	40,9	<b>53,6</b>
Latvia	46,4	<b>60,7</b>	69,3	68,1	67,8	68,0	<b>68,3</b>	69,9	<b>75,9</b>
Lithuania	28,8	<b>49,6</b>	67,6	67,0	66,8	67,2	<b>68,0</b>	70,6	<b>78,1</b>
Malta	88,9	<b>89,7</b>	90,4	92,4	94,1	94,4	<b>94,7</b>	95,4	<b>96,6</b>
Norway	50,5	<b>65,4</b>	72,0	76,0	79,1	81,1	<b>83,0</b>	86,1	<b>90,2</b>
Poland	38,3	<b>52,1</b>	61,3	61,7	60,9	60,3	<b>60,0</b>	61,5	<b>70,4</b>
Portugal	31,2	<b>38,8</b>	47,9	54,4	60,6	63,5	<b>66,3</b>	71,4	<b>79,3</b>
Republic of Moldova	18,5	<b>32,1</b>	46,8	44,6	42,6	42,5	<b>42,8</b>	45,5	<b>56,9</b>
Romania	25,6	<b>40,3</b>	53,2	53,0	53,8	53,9	<b>54,2</b>	56,6	<b>66,7</b>
Russian Federation	44,1	<b>62,5</b>	73,4	73,4	73,7	74,1	<b>74,8</b>	77,1	<b>83,3</b>
Serbia	20,3	<b>39,7</b>	50,4	52,8	55,0	55,7	<b>56,4</b>	59,3	<b>68,8</b>
Slovakia	30,0	<b>41,1</b>	56,5	56,2	54,7	53,9	<b>53,8</b>	55,6	<b>65,7</b>
Slovenia	19,9	<b>37,0</b>	50,4	50,8	52,7	53,8	<b>55,1</b>	58,8	<b>68,8</b>
Spain	51,9	<b>66,0</b>	75,4	76,3	78,4	79,6	<b>80,8</b>	83,3	<b>88,0</b>
Sweden	65,7	<b>81,0</b>	83,1	84,0	85,1	86,6	<b>88,0</b>	90,3	<b>93,2</b>
Tajikistan	29,4	<b>36,9</b>	31,7	26,5	26,5	26,7	<b>27,5</b>	30,8	<b>43,0</b>
Turkmenistan	45,0	<b>47,8</b>	45,1	45,9	48,5	50,3	<b>52,5</b>	57,9	<b>68,9</b>
Ukraine	35,5	<b>54,8</b>	66,8	67,1	68,6	69,1	<b>69,6</b>	71,7	<b>78,6</b>
United Kingdom	79,0	<b>77,1</b>	78,1	78,7	81,3	82,6	<b>83,9</b>	86,3	<b>90,2</b>
Uzbekistan	28,9	<b>36,7</b>	41,4	46,1	51,0	50,8	<b>50,4</b>	51,8	<b>61,5</b>
Netherlands	56,1	<b>61,7</b>	68,7	76,8	87,1	90,2	<b>92,2</b>	94,8	<b>96,6</b>
Switzerland	67,4	<b>73,8</b>	73,9	73,4	73,6	73,7	<b>73,9</b>	75,4	<b>81,4</b>

<sup>165</sup> <https://population.un.org/wup/Download/>, the Population Division of the United Nations Department of Economic and Social Affairs (UN DESA), 2018 Revision of the World Urbanization Prospects.

## Annex 1.2 Principles of the distribution of street space between traffic users<sup>166</sup>



## Annex 1.3 THE PEP High Level Meetings and Declarations since 2001

- 2001. First High-level Meetings on Transport, Health and Environment
- 2002. Establishment of THE PEP. 2<sup>nd</sup> PEP policy framework steering committee
- 2009. Amsterdam Declaration. 3<sup>rd</sup> PEP policy framework steering committee
- 2014. Paris Declaration. 4<sup>th</sup> PEP policy framework steering committee
- 2019. 22-24 October, Vienna (Austria). 5<sup>th</sup> PEP policy framework steering committee

<sup>166</sup> A slide from a presentation of Prof. Yoshitsugu HAYASHI, Professor Dr-Eng., Institute of Science and Technology Research, Chubu University, Japan. Full Member, Club of Rome. President, WCTRS (World Conference on Transport Research Society) (Japan), 2018.

**Annex 1.4 THE PEP Relay-race Workshops 2008-2018**

<b>WHERE</b>	<b>WHEN</b>	<b>WORKSHOP</b>
<b>Rimini, Italy</b>	<b>2018</b>	Active mobility - Making the change towards a green and healthy urban transport environment
<b>Saint Petersburg, Russia</b>	2018	Introduction of innovative green and healthy technical and technological solutions in road and urban passenger transport: global trends and opportunities
<b>Mannheim, Germany</b>	2017	Cycling and Walking
<b>Vladivostok, Russian Federation</b>	2016	Sustainable transport planning in big cities
<b>Vienna, Austria</b>	2016	Decarbonization — Zero emission mobility starts now!
<b>Petrozavodsk, Russian Federation</b>	2016	Burdens and benefits of motorized and non-motorized transport
<b>Irkutsk, Russian Federation</b>	2015	Integrating Transport, Urban Planning and Traffic Management
<b>Kaunas, Lithuania</b>	2014	Sustainable Mobility for Better Health and Environment
<b>Almaty, Kazakhstan</b>	2013	Sustainable Mobility: Focus on Urban Central Asia
<b>Moscow, Russian Federation</b>	2012	Sustainable Development of Urban Transport
<b>Kyiv, Ukraine</b>	2011	Working together for sustainable and healthy urban transport
<b>Batumi, Georgia</b>	2010	Safe and healthy walking and cycling in urban areas
<b>Pruhonice-Prague, Czech Republic</b>	2009	Safe and healthy walking and cycling in urban areas
<b>Skopje, FYROM</b>	2009	Sustainable urban transport policies in south-east Europe
<b>Chisinau, Moldova</b>	2008	Sustainable and healthy urban transport

## Annex to Chapter 2

**The practice of successful combination of urban and transport planning together with a list of measures required to build and develop sustainable urban transport systems<sup>167</sup>**

Activity area	Practice of successful cities	Measures to build and develop sustainable urban transport systems
<b>Strategic planning and development of sustainable transport systems integrated with urban policy and urban planning</b>	<p>Availability of strategic planning and development of sustainable transport systems integrated with urban policy and urban planning.</p> <p>Tools to limit the demand for private car use in areas of urban development.</p> <p>A mechanism introduced to prioritise efficiency projects (geared at minimising costs, damage from environmental pollution and the number of accidents per passenger transported).</p>	<p>Formulation of a strategy for the development of sustainable transport systems.</p> <p>Formulation of Sustainable Urban Mobility Plans.</p> <p>Integration of spatial and urban planning legislation with transport planning strategic documents.</p>
<b>Financing</b>	<p>Predictable financial resources, efficient budget allocation, long-term planning.</p>	<p>Improving long-term budget sustainability and predictable planning and allocation of financial resources.</p> <p>Targeted financial support for sustainable urban transport activities.</p> <p>Identification of priority areas for expenditures.</p>
<b>Development and management of urban public transport operations</b>	<p>Ensuring high quality urban public transport (safe, quality, accessible, reliable, comfortable, environmentally friendly). Qualitative satisfaction of existing demand to be more competitive against passenger cars.</p> <p>Pursuing the practice of competitive bidding and ensuring commercial liability of operators.</p> <p>Advancing digital technologies in transport and logistics, implementation of the concept of “Mobility as a Service” (Maas). Use of ITS, new information and organisational technologies. E-Mobility development.</p> <p>An affordable pricing policy for all categories of citizens, convenient tariff menus, single ticket (universal fare system),</p>	<p>System integration of all types of public transport.</p> <p>Approval of local social standards for transport service quality with high consumer quality standards set. Route networks must be designed and put in place based on quality requirements, targeted cost-saving and externalities. Targeted quality monitoring.</p> <p>Targeted programmes aimed at the development of high-speed passenger transport.</p> <p>Commercialisation of municipal transport companies and consolidation of private carriers in the context of growing competition.</p> <p>Convenient tariff structure; introduction of a universal fare system.</p> <p>Efficient route network planning.</p> <p>Improving the quality of urban public transport operations (safe, quality, accessible, reliable, comfortable, environmentally friendly). Implementation of Maas services. Use of new information and organisational technologies.</p> <p>Prioritising the movement of route vehicles,</p>

<sup>167</sup> Developed by the UNECE consultant Rimma Filippova, 2019.



Activity area	Practice of successful cities	Measures to build and develop sustainable urban transport systems
	informing passengers in real time, route landmarks, convenient routes and schedule.	including by dedicated lanes. Advancing digital technologies in transport and logistics, implementation of the concept of “Mobility as a Service” (Maas). E-Mobility development. Use of ITS, new information and organisational technologies. Convenient tariff menus to promote the use of public transport for the population that would be uniform for carriers regardless of the form of ownership. Raising public awareness of passenger transport; introduction of real-time passenger waiting time information systems to keep passengers up-to-date about the movement of vehicles en route. Ensuring long-term and stable operating conditions for providers, introducing improvements into the fare system. Implementing targeted mechanisms to ensure affordable fares for low-income groups of population (targeted benefits for low-income persons; targeted transport subsidies). Conducting assessments of the economic and budgetary efficiency of the way public transport is organised; striking a balance between the level of quality provided and budget expenditures.
<b>Road and street network</b>	<p>The road and street network should develop aligned with the needs and at the necessary scale.</p> <p>Clear priorities for investments into the development of road and street networks.</p> <p>Application of advanced techniques in equipping and maintaining roadways. Building street and road networks in adherence to the “Livable City” goal.</p>	<p>Regular roadway surveys. Vigorous implementation of automated traffic control systems in cities.</p> <p>Implementation of innovative “environmentally friendly and sound” technical and technological solutions.</p>
<b>Road traffic management</b>	Ensuring a balance between the transport demand of the population and the functionality of sustainable urban transport systems.	<p>Integration and reinforcement of engagement between authorities and providers.</p> <p>Introduction of advanced technologies in road traffic management.</p> <p>Use of new information and organisational technologies.</p> <p>Application of ITS. Enhancing design quality in road traffic management.</p>
<b>Reducing regular congestion affecting urban road and street networks</b>	Taking measures to achieve a reasonable restriction of movement of privately owned vehicles, imposing restrictive measures to limit the traffic of freight vehicles.	<p>Imposition of restrictive measures on privately owned vehicles as well as on the traffic of freight vehicles.</p> <p>Ensuring the required laws and regulations; introduction of amendments to the legislation currently in force.</p>

Activity area	Practice of successful cities	Measures to build and develop sustainable urban transport systems
<b>Organisation of urban parking space</b>	Pursuing comprehensive approaches to the organization of single urban parking space. Enforce measures to restrict the traffic of privately owned vehicles within reasonable limits.	Formulate a comprehensive strategy to organise single urban parking space. Approval of relevant legislation. Clarify and expand the powers of cities in regard to the parking policy and its enforcement.
<b>Safety management</b>	Integrate safety into the overall strategy of road traffic management. Implement “traffic calming” and speed reduction techniques and in certain parts of the street and road network, traffic cameras, fiscal measures, fines, etc.	Step up the availability of high-tech equipment in street and road networks. Streamline the development procedures of pre-design and design documentation. Improve the quality of design in road traffic management, apply best practices (traffic calming, speed reduction, traffic cameras, strict fiscal measures, etc.).
<b>Environmental protection and mitigating the impact of motorised transport on climate change and public health</b>	Concerted efforts with powers and responsibilities divided between federal, regional and municipal authorities in the field of regulation, monitoring and enforcement of environmental standards and mitigation of adverse environmental impacts.	Ensure a rational balance of regulations and incentives. Strengthen the accountability for failure to comply with environmental regulations. Develop methods for assessment of environmental and public health damage. Assess the volume of pollutants discharged into the atmosphere due to motorised transport; support and encourage the introduction and development of “environmentally friendly” vehicles and technologies. Introduce scrapping schemes for old cars: speed up vehicle fleet renewals by providing fiscal incentives for scrapping old cars, encouraging changes in public behaviour stereotypes towards public transport service and non - motorised modes of transport. Remunerate drivers who opt for more efficient vehicles. Introduce a fuel efficiency labelling for new vehicles. Make fuel efficiency and emission standards more stringent.
<b>Comfortable urban environment and “living green” streets</b>	Implementation of “Cities for People” strategies that intertwine efficiently urban and transport planning from the perspective of street and road networks, public spaces, green spaces, pedestrian spaces, cycling, etc. Accessibility, reliability, safety and quality must be prioritised.	Elaborate “Cities for People” strategies with urban and transport planning expressly interlinked. Impose restrictions on the traffic of motorised transport while putting in place and ensuring a comfortable and convenient street environment. Wise distribution of all road users in urban space with appropriate traffic safety provided. Accessibility, reliability, safety and quality must be prioritised.
<b>Support and develop non-motorised modes of transport</b>	Provide appropriate infrastructure and ensure that it is properly maintained (cycle lane, bicycle rental, bicycle parking, Internet services, etc.). Ensure the safety of cyclists under the “Safe System	View non-motorised modes of travel as a viable alternative to the use of privately owned vehicles for short (up to 1 km) and medium distances (up to 3-5 km). Implement advanced techniques and means in organising the traffic of cyclists and ensure their safety in real traffic taking into account different climatic conditions. Use incentives. Put in place

Activity area	Practice of successful cities	Measures to build and develop sustainable urban transport systems
	<p>Approach” and the “Vision Zero” approach.</p> <p>Apply incentives to promote the use of non-motorised modes of transport and travel.</p> <p>Promote mobility through the mutual integration of public transport, cycling and car sharing.</p>	<p>necessary infrastructure and means to maintain this infrastructure. Develop and implement a consolidated public policy aimed at developing cycling. Integrate all modes of transport, including non-motorised modes of transport with the transport policy geared towards changing the transport behaviour of the population. Implement methods to assess the socio-economic efficiency of the measures and decisions being taken to promote cycling.</p>
<p><b>Enhance energy efficiency and energy saving in the road transport sector</b></p>	<p>Implement energy efficiency measures in the transport sector to save significant amounts of energy; support and advancement of “clean” technologies and motorised vehicles (such as LRT, trams, trolleybuses, electric buses, electric vehicles, hybrid electric vehicles).</p>	<p>Implement measures to give a boost to energy efficiency in the transport sector to save substantial amounts of energy; support and promote the introduction and advancement of “environmentally friendly” motorised vehicles and technologies; draft and enact relevant laws and regulations. Pursue measures to cut down the share of privately owned cars to reduce the overall energy burden and to enhance the energy efficiency of passenger carriage through public transport. Reduce the fuel consumption of motorised transport. Reduce the energy intensity of new privately owned cars. Introduce a fuel efficiency labelling for new vehicles. Introduce a system of efficiency improvement in the transport sector. Make fuel efficiency and emission standards more stringent.</p>
<p><b>Implement green logistics and ensure the reliability of road transport</b></p>	<p>High accessibility.</p> <p>Ensure “door-to-door” cargo delivery.</p> <p>High maneuverability.</p> <p>Quick delivery.</p> <p>Make available different routes and delivery schemes.</p> <p>“Environmentally friendly” cargo vehicles.</p>	<p>Accessibility, reliability, safety and quality are the priority. Seek reductions in fuel consumption by road transport, ensure the use of “environmentally friendly” trucks, apply incentive measures. Ensure “door-to-door” cargo delivery. High maneuverability.</p> <p>Quick delivery. Ensure the use of different routes and delivery schemes.</p>

## Annex to Chapter 5

### Structure of the Wales travel Act

Theme	Number	Action
<b>Leadership</b>	1.	Ministerial oversight to implementation of the Active Travel Act and Action Plan and champion cross-departmental co-ordination provided by Minister of Economy, Science and Transport. Examples of Ministerial cross departmental activity reported through the annual report
	2.	National strategic oversight of delivery of the Active Travel Act and the Action Plan by The Active Travel Board.
	3.	The Welsh Government works closely with local authorities to communicate how active travel directly supports the well-being goals and benefits cross service delivery.
<b>Legislation, Standards and Tools</b>	4.	Subordinate active travel legislation remains under review, learning from early implementation of the Active Travel Act.
	5.	Determine best approach to improving road safety in Wales for pedestrians and cyclists. Consider legislative opportunities for strengthening active travel.
	6.	We will keep the Design Guidance under review, building on feedback from local authorities on the use of different design elements.
	7.	The Active Travel Data Management System: capture, manage and publish information on active travel infrastructure in Wales. Provide public access to key information.
	8.	Incorporate the consideration of health impacts into a revised WelTAG.
	9.	Consider further updates to TAN 18: Transport and TAN 12: Design to further promote active travel through the planning system.
	10.	Encouragement of schools to raise awareness of the importance of active travel to the health and well-being of pupils.
	11.	Explore the strengthening of the active travel elements of both the Corporate Health Standard and the Welsh Network of Healthy Schools Schemes National Quality Award.
<b>Infrastructure</b>	12.	Develop the strategy for funding active travel infrastructure investment.
	13.	Ensure provision for walkers and cyclists in terms of direct investments in transport infrastructure.
	14.	We will continue to make grant funding available for high quality local active travel schemes.
	15.	Require consideration of access for walkers and cyclists before supporting capital investments.
<b>Promotion &amp; Behavior Change</b>	16.	Development of an active travel promotion and engagement toolkit.
	17.	Development of the national communication strategy for active travel.
	18.	Work with Traveline Cymru to explore the improvement and marketing their active travel journey planner.
	19.	The promotion of Active Travel in schools including pedestrian and cycle training. Encouragement of closer links between complementary school-based programs.



	20.	Reviewal of the role of travel plan coordinators in providing support to organizations. Form partnerships in order to identify complementary programs and suitable additional behavior change interventions.
	21.	Monitor conflict between transport user groups and identify measures to improve their interaction.
<b>Skills Training &amp;</b>	22.	Offer training on the use of the Design Guidance and enable interactive learning on other aspects of active travel.
	23.	Develop mechanisms to enable practitioners to share experience and provide feedback.
	24.	Seek out opportunities to raise awareness of the Act and its aims and requirements among transport, health and education professionals, and local councilors.
<b>Monitoring &amp; Evaluation</b>	25.	Develop active travel targets and work with local authorities to develop a consistent local monitoring and reporting framework.
	26.	Continue to require Welsh Government funded schemes the effective monitoring and evaluation.
	27.	Explore opportunities to enable and encourage sharing of monitoring and evaluation results.
	28.	The Action Plan will be monitored by the Active Travel Board on an on-going basis. Updates included in annual Reports.

## Annex to Chapter 6

### General characteristics of Moscow Ring transportation project

- Travel time of electric trains — 90 minutes;
- Route length — 54 km;
- Number of stations — 31; all adapted for barrier-free movement of passengers with reduced mobility;
- Traffic intervals — 5 minutes during peak hours and 10 minutes during non-peak hours;
- The line is operated by 42 “Lastochka” electric trains;
- Working hours: 5:30 am to 1:00 am

**HANDBOOK ON SUSTAINABLE URBAN MOBILITY AND  
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A practical guide featuring over good practices and case studies on integrating transport, environmental, health and quality of life objectives into urban and spatial planning policies

**Preliminary draft V10**

**August 20 2019**