UNECE HANDBOOK ON SUSTAINABLE TRANSPORT AND URBAN 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

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“Emissions from the EU transport sector are not reducing enough to limit its environmental and climate impacts in Europe. 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.”

Foreword by the UN Secretary General (tbc)
Foreword by UNECE Secretary General (tbc)
Editorial team
(…)

Consultants
(…)

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Chapter 1. Sustainable Urban Mobility
Chapter 1. Sustainable Urban Mobility

1.1 Global trends challenges and forecasts

1.1.1 The quest for hypermobility in times of rising resources limitations

In the past twenty years, the role of infrastructures to promote and sustain economic growth has been acknowledged (Calderon and Seven, 2004). After the 2008 financial crisis, infrastructure investments have been pushed as drivers for economic recovery and growth (Yifu, 2012). Sustainability has made its way in the debates between post Keynesian ecological economics and neo classics (Holt, 2010). The need for green infrastructures has been emphasized, such as climate friendly railways and waterways, clean and renewable energy projects etc. (ADBI & ADB, 2008, Bielenberg et al., 2016, OECD, 2018).

Along with climate change, urbanization is the other contemporary transformative mega-trend (WBGU, 2016). It goes with metropolisation, a less studied feature of global policy-making (Katz, 2013, Ahrendt et al., 2015, Gomez et al., 2017), a catalyst for the quest for more mobility of people and goods. Contrary to the vision of a prosperous post Cold-War world of global cities (Sassen, 2001) our world is of more than 4.000 cities of +100.000 inhabitants and 1.000 metro areas of +500.000 inhabitants across the globe (UNDESA, 2016). This complex and conflicting intertwining of local and global scales is both an issue of macro- and micro economics. Many metro-regions surpass countries GDP. And yet, there is no corresponding multi-level governance (Snower, 2019).

With over 70 million more people living in urban areas annually (World Bank, 2018) and a forecast of 6,5 billion urban dwellers by 2050, urbanization is a source a global growth...with many problems. Investment gaps are widening, inequalities are rising (OECD, 2018), territorial and social cohesion is at risk (Fleurbaey et al., 2018). Moreover, land-use policies are massively ailing (Seto et al., 2012; Angel, Galarza et al., 2016) and the ecological footprint of human activities is rising faster than ever before (Boulding, 1966; Meadows et al., 1972).

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1 This section is adapted from The Infrastructure Nexus, T20 Japan, N.Buchoud et al. 2019, for the purpose of the UNECE THE PEP report
2 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
3 Real estate markets should account for more than US$ 4,3 trillion by 2025 (Grand View Research Inc, 2018) and yet the affordability gap is ceaselessly growing, estimated at more than US$ 650 billion per year (UN Habitat, 2018). Depending on sources, the global smart cities markets should account for more than US$ 2 trillion per year (Frost & Sullivan, 2018) to US$ 3.5 trillion per year (Research and Markets, 2017) by 2025. Yet, there is little evidence that internet 3.0, IoT, industry 4.0... are self-help drivers for inclusive territorial development (Eubanks, 2018, Temin, 2017). While in cities and regions across the globe, citizens are struggling with congested mobility systems, social networks, design, television and cinema, literature, including cartoons and mangas, are boiling with anticipation and science fiction, all about cities and their future virtual and physical infrastructures. Creative industries as a whole shape global (urban) imaginaries worldwide with a market of more than US$ 2 trillion per year (PWC, 2015, WCCE, 2018).
4 There is a high probability (> 75 %) that large areas of the European continent totaling approximately 77.500 km2, that is the equivalent of the total surface of Belgium and the Netherlands together, will be or have been converted to urban areas between 2000 and 2030 (Seto et al., 2012).
Wackernagel, 1996; Rockström, 2009; Sachs, 2015). This is the new normal for infrastructure investments, only that solid evidence about future cities-and corresponding infrastructure and mobility systems-is still to be built up.

In the absence of a clear pathway regarding optimal cityshape ensuring equality, sustainability and growth (Salat et al., 2012; Ahfeldt, 2017), communication about off-grid local experiments or the investments in designated smart urban mega projects tends to be overemphasized. In developed countries, the management costs of existing infrastructures are soaring, citizens’ reluctance or resistance to new projects is growing, despite a growing need for mobility. In low and middle income countries, the lack of infrastructures and infrastructure finance threatens long-term growth (Floater et al., 2017) and the environment.

Following over a decade of loosely coordinated action and policy-making at combined micro, metro and macro-scales (Buchoud, 2019),5 we have reached a turning point. As illustrated by the Nationally Determined Contributions (NDCs) to reach the Paris agreement and the Voluntary National Reviews of the SDGs, the call for cross-sectoral approach to urbanization, mobility and infrastructure development is getting higher on local, regional and global agendas (IISD, 2017, AFD, et al., 2018). It still is to be transformed into applicable policies.6

In the transition towards the decoupling of economic growth from carbon emissions (Snower, 2018), a new approach to infrastructure projects is emerging, connecting hard and soft infrastructures, infrastructure finance and users’ behaviors, civil and financial engineering, changing industry processes (WEF, 2017; Kelly, 2019) and the development of inclusive infrastructures (Mc Kinsey, 2016; IDB, 2018). Besides, mobility is fast changing with digitalization offering a wealth of new opportunities to move from siloed to platform or even distributed approaches, in a context of hypermobility7. Yet, two problems are not being addressed.

The first one is a confusion between urbanization and urban infrastructures. Cities and metros need infrastructures, be mobility, energy, etc. But infrastructures serving interconnected urban areas are metropolitan, national, regional, continental, or even global. They go far beyond city limits yet with no corresponding urban governance at those combined scales. Hence, the quest for autonomous off-grid settlements on the one hand (Lemoine, 2014), and the development of new geopolitical infrastructures on the other hand, such as the One Belt One Road initiative led by China, with little left in-between.

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5 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 21st 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 CO2 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 15th meeting of the Conference of the Parties to the Convention on Biological Diversity (COP15) to be hosted by China in 2020.

6 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.

7 Despite the invention of Transit Oriented Development (Calthrope, 1993), the number of motorized vehicles and especially private cars in the world is expected to reach 1,5 billion in 2020, out of 675 million in 1990 (Sperling and Gordon, TRB, 2009, UNECE, 2015).
The second problem is a chronic deficit of knowledge about what a global future of cities and metros means to citizens, public and private investors, governments…and the whole value chain of mobility and transportation\(^9\). As an illustration as of 2018, the total market value of the world’s largest global ride-hailing companies was about US$ 100 billion, a calculation is 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 (circa US$ 20.1 billion, source GLA 2018) and the Grand Paris Express metro network serving the Greater Paris metro area by 2030 (circa € 38 billion or US$ 43 billion, source Société du Grand Paris, 2018), two of the world’s largest metropolitan transportation infrastructure projects. Not only are large scale infrastructure projects costly to finance.

The third problem is the growingly complex issue of governance and regulation while individual mobility is a core social and economic value. Alternatively, integrated infrastructures may support the implementation of « quantity based regulation ». Assume that each citizen or economic agent is endowed with a given amount of “mobility permits”, defined consistently with the maximal volume of transport-related negative externalities to be emitted (e.g. GHG or local pollutants quotas), but also with social considerations (e.g. people living in depraved areas, far away from the city center, receive more permits). An integrated and ICT-based interface between the users and the transport infrastructures could be an efficient way to implement and to monitor the system (your permits’ account will be debited differently if you’re using subways, bikes or cars; for 1 or for 10 kms), as well as to organize a market where economic agents who have an excess volume of permits could sell them to those who need to travel (and to pollute) more.

It took thirty years for IPCC to build evidence, knowledge and science-to-society interface about climate change. At the same pace, we would have to wait until 2050 to deploy to renew science-to-policy partnerships in the field of urbanization, with a priority on informality, urban planning and design, green and blue infrastructures (Parnell et al., 2018). As we are touching upon limitations of natural resources and the regeneration of ecosystems is questioned (Silvain et al., 2018, Nofal et al., 2019), 2050 is way too far a horizon.

What if the UNECE region 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 preventing urban sprawl as well as the rampant new trend of “mobility sprawl”?

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\(^8\) Source of the illustration: The Guardian

\(^9\) A recent survey in 347 districts of England and Wales shows that while multi-billion pound investments in high-speed rail increased averages wages by 2% in the region, its impacts on districts was quite heterogeneous and sometimes negative (Fingleton and Szumilo, 2019).
1.1.2 UNECE region road users still love cars

In Western Europe, the United States and a number of other developed countries, car ownership generally rose steadily until the late 2000s and early 2010s, reaching a peak number of 400-600 (in the United States - 800) cars per 1.000 inhabitants. Out of the UNECE region and according to statistical evidence from the countries that shared relevant data for the period under examination, Lithuania and the United Kingdom were the only countries to show a (light) decline in car ownership11.

With the majority of the population in the UNECE region residing in urban areas, the region in CIS countries, the “car ownership” trend has been quite high over the past 25 years. However, as initial reference values were low, the current motorization level of these countries is markedly lower than that of developed countries. That notwithstanding, many of the largest cities in these countries see the level of car ownership nearing the mark of 300-400 cars per 1.000 inhabitants with a steady tendency to rise further. In parallel with the growing number of privately owned cars, most countries have until recently seen (and the trend still persists in many countries) an increase in car usage measured in kilometres travelled per capita.

In Europe, the trend is opposite, driven by local governments and the civil society which describe private car ownership and private car mobility (especially fossil fuel cars) as major hurdles on the way to more sustainable livelohods. The equation is not that simple as shown by recent smassive osical upheavals in France, triggered by proposed additional taxation on fossil fuels and especially diesel to help fund a more carbon neutral economy, along with measures to lower speed limits on the national road network. Around major urban cores, in periurban and rural areas, car ownership is not just an issue of lifestyle that can be changed according to fashionale trends. Instead, car dependency is strongly impacting behaviours.

All across UNECE countries, global trends are changing mobility patterns and affecting transportation systems and vehicles, be it electro mobility, shared mobility, active mobility, with impacts on the industry, the society and urban governance choices. The rapidly rising digitalisation of the economy offers many opportunities to rethink urban patterns and mobility issues, which in the future, will require a lot of cross sector and multi-stakeholder coordination.

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11 file:///C:/Users/User/Desktop/%D0%95%D0%AD%D0%9A%20%D0%9E%D0%9D%20%D0%9E%D0 %9F%D0%A2%D0%9E%D0%A1%D0%9E%07/2017_INLAND_TRANSPORT_STATISTICS.pdf, Inland Transport Statistics for Europe and North America, UN, New York and Geneva, 2017, ECE/TRANS/260.
1.1.3 Accessibility and development versus congestion?

“A city living on total automotive dependence becomes dysfunctional, inefficient and inconvenient for life. The goal of the transport system is to move people, not vehicles.” ¹²

Researchers of urban transport systems in different countries and cities concur that with the unbridled rise in the use of privately owned cars, traditional and mature cities are no longer comfortable for living, that is, the collision of cities and cars is recognized as an objective reality.

Urban population growth and expanding urban areas engender both rising transport demand and population mobility and challenges related to the accessibility of certain urban areas, transport destinations and transport services. The growing congestion of transport networks (road networks) and increasingly congested public transport systems are seen taking a toll on transport accessibility. The congestion of urban road networks in large cities is the consequence of transport demand being disproportionate to the capacity of available road infrastructure. This results in traffic congestion.

OECD estimates the annual economic damage associated with delays in passenger transport and cargo due to traffic congestion in Europe at $100bn, or more than 1.0% of the GDP of EU countries. Around 80% of all traffic congestion occurs in urban areas.¹³

For many years, administrations in major cities considered ramping up the capacity of urban roads through their reconstruction and construction of new ones as the principal measure against traffic congestion. The respective transport planning concepts adopted in the century known for “rapidly developing motorisation” were premised upon the paradigm of “Planning for Cars in Cities”. As has been evidenced by practice, such attempts to tackle the issues of increasing the accessibility of urban areas and easing congestion never yielded long-term positive outcomes due to the emergence of so-called new “induced” mobility.

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¹² B. Vuchic.  *Transportation for Livable Cities*

“Sustainable Mobility” which sought to ensure the mobility of population by reorienting transport demand towards safer and more environmentally friendly modes of transport (“urban mobility planning”).

City and public authorities in charge of the transport policy find themselves confronted with institutional barriers, legal and financial constraints as well as political and social backlash. This being the case, it is critical for cities at the very outset to define their goals properly, assess the issues at hand, find potential solutions and adopt an appropriate strategy so as to go ahead with implementing the plans, then evaluate the outcome and conduct monitoring.

However, with all the positive aspects of this approach that is to some extent implemented by the administrations of many major cities, it should be acknowledged that it stems from the given transport demand for which the public transport service system is designed. Planning of cities and their transport infrastructure “around motor-vehicle traffic (transport mobility)” continues to produce major externalities associated with transport activities, in particular, leading to 1.250.000 road accident deaths and 3.200.000 premature deaths from air pollution per annum.

Bearing this in mind, the need to “shift our dominant transport paradigm towards focusing investments on creating bright, energetic and lively urban areas adapted to accommodate the livelihood of people is becoming increasingly clear.” The significance of this approach to urban planning is now being acknowledged by a growing number of scientists and specialists. This reorientation of transport planning priorities is intended to complement the basic planning principles of sustainable urban transport systems, such as:

- creation of efficient alternatives to the use of privately owned vehicles;
- implementation of transport demand management mechanisms;
- development of means of active mobility;
- effective integration of transport and urban planning;
- engagement of stakeholders through a transparent and participatory approach, etc.

1.1.4 Transport versus the environment?

Transport activities, particularly in urban areas, remain a major source of emissions of air pollutants and noise. New data from the World Health Organization (WHO) show that, at the global level, 9 out of 10 people breathe air containing pollutants exceeding the WHO air quality guidelines.

Exposure to ambient air pollution is estimated to cause almost 500,000 premature deaths per year in the WHO European region. Road transport is an important contributor to emissions of greenhouse gases, which contribute to climate change. The share of carbon dioxide emissions arising from transport could reach 40 per cent of the total globally by 2030 in a business-as-usual scenario.

The health-related effects of climate change include an increase in the frequency and severity of extreme weather events, such as heatwaves, droughts, flash floods, cold spells and changes to the patterns of vector-borne diseases, such as malaria and tick-borne encephalitis. Environmental noise has emerged as one of the top environmental risks to physical and mental health and well-being. In spite of limitations in the availability of data across the pan-European region, it is estimated that at least 100 million people in the European Union are affected by road traffic noise levels exceeding WHO guideline values. In western Europe alone, at least 1.6 million healthy years of life are lost as a result of road traffic noise. Road traffic injuries are the leading cause of death among young people aged 5–29 years and cost governments approximately three per cent of gross domestic product. About one in four road deaths involves a pedestrian or a cyclist. Transport operations entail a series of combined negative effects including physical inactivity, air pollution, psychosocial impacts such as from noise, negative impacts on nature, landscape and biodiversity of transport infrastructures, climate change, injury rate due to traffic hazards etc.

Transport and, above all, motor vehicles are the largest source of pollution for the environment. Over 200 different substances are released into the atmosphere as a result of fuel combustion in vehicle engines. The main hazardous components of vehicle emissions are traditionally recognized as nitrogen oxides (NOx), hydrocarbons (VOC and NMVOC), particulate matter (PM), carbon monoxide, sulphur oxides (SOx) (Fig. 1.8).

Figure 1.6 Pollutants and climate gases emitted by motor vehicles
- Traditional gas sources: CO, VOC, NOx, S02, Pb, NMVOC, NH3
- Gas sources with an impact on climate: CO2, N20, CH4
- Unconventional sources: Acrolein, 1,3-butaiene, toluene, xylene, styrene, acetaldehyde, benzene, formaldehyde, benzo(a)pyrene.

Figure 1.7 Aspects of motor vehicle environmental safety

As reported by the European Environment Agency, the air pollution damage inflicted by motor vehicles in EU countries stood at €100 billion per year as of 2013 [May]. The detrimental impact of vehicle emissions on public health is the main component of this damage. Air pollution is the cause of 350,000 premature deaths per year in EU countries, while emissions from heavy trucks alone inflict health damage to the extent of €43-46 billion per year. Moreover, vehicle emissions negatively affect the state of flora and fauna along with the condition of buildings and structures.

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It is not only with the toxic components of exhaust gases that motor vehicles pollute the atmospheric air and the environment, but also with fuel vapours, tire wear and road wear products, brake lining wear, etc.

Another challenge is the impact of transport on global climate change. Ample scientific evidence suggests that a temperature rise of 2°C results in a substantial increase in the risk of extreme climatic events, such as sea level rise, forest fires, floods, ecosystem degradation and severe droughts (IPCC, 2014), which pose a major threat to the environment and human health. Transport, especially motorized transport, is one of the largest sources of climate gas emissions (CO2, N2O, CH4). The transport sector accounts for 23% of total CO2 emissions from fuel combustion (IEA, 2016). In addition, transport-related emissions increase faster than emissions from any other sector of the economy (ITF, 2017).

Continued urban population growth and economic development around the world will further fuel transport demand in the coming years, which in turn can speed up the rate of growth in CO2 emissions from urban passenger transport. Constraining the global average temperature growth to 2°C will pose a challenge as urban passenger transport is projected to grow by 60 to 70 percent by 2050 as compared to 2015 levels (ITF, 2017; IEA, 2016). Total motorized mobility in cities may increase by 94% between 2015 and 2050, translating into a 26% global increase in CO2 emissions resultant from urban mobility growth alone (ITF, 2017).

It should be noted that measures directed at improving the energy efficiency of motor vehicles and thereby reducing their CO2 emissions also serve to curtail vehicle pollutant emissions.

1.1.5 Mobility versus health and well-being?

The negative effects of transport activities are chiefly related to the impact which transport has on the lives and health of the population and the resultant decline in the quality of life. The life and health of the population are affected by road safety, the impact produced by transport on the environment and reduced physical activity as a consequence of excessive use of private cars. Air pollution is ranked 4th in the list of global health risk factors.

The carcinogenic risks arising from particulate emissions released by diesel engines are much higher than the same risks associated with other pollutants.

Figure 1.8-1.9 Cancer risks associated with toxic air pollutants (source?)

Motor vehicles stand out among other sources of pollutant emissions into the atmosphere due to the exhaust gases that they produce being released into the atmosphere at the ground level making it difficult for them to disperse. Fig. 1.10 shows the proportion of the population with chronic non-communicative diseases living along urban motorways in 10 European cities.
Public health is also affected by climate change. According to the World Health Organization, about 250,000 additional deaths per year will be caused by climate change between 2030 — 2050. It should also be taken into account that the share of motor vehicles surpasses 35% of the emissions covered by the Climate Action Regulation, which sets goals for the Member States to reduce GHG emissions in the sectors not incorporated in the Emission Trading Scheme until 2030 ["Impact of vehicle CO2 standards on national transport emissions" T&E, Published on September 27, 2018].

The impact of transport and, in the first instance, that of motor vehicles on the environment and public health constitutes a major factor in determining the well-being of the population. Well-being is sometimes viewed as a synonym or essential element of the quality of life, an essential component of the broad and so much indefinable concept of “happiness”.

The increase in morbidity and mortality associated with the operation of motor vehicles leads to significant additional expenditures on public medicine as well as incurring costs for budgets at all levels. That is why different governments pay special attention to the issues of prevention of morbidity and mortality, including those stemming from the impact of transport, and, therefore, quality planning for urban areas where transport systems are a critical factor in urban sustainability. Against this background, the development of various kinds of active mobility is the most important area of all in sustainable urban transport planning.

The benefits yielded by active urban mobility are enjoyed both by individuals in terms of their own health care costs going down, by city authorities in terms of reducing health care expenses, as well as businesses by virtue of strengthening the appeal of business entities (cafes, restaurants, shops).

Research results indicate that with the costs associated with the treatment of diseases caused by pollution, accident risk assessment, etc. taken into account, it turns out that every kilometre travelled by car in the EU countries costs society on average 0,15 € whereas every kilometre travelled cycling benefits society in the form of 0,16 € thanks to the improvement of public health.

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health and the absence of negative effects associated with car use\textsuperscript{17}. The positive impacts of active mobility on the economy are numerous such as:

- reducing noise and pollutant emissions into the atmosphere;
- achieving less congested roads;
- lowering the number of road injuries;
- reducing expenses on road infrastructure;
- improving accessibility and quality of urban life;
- enhancing the physical activity and health of the population;
- promoting tourism and job creation.

Figure 1.12 The contribution of cycling and walking to the economy of London

Studies point to the development of active mobility having a beneficial effect on urban economy development. Pedestrians and cyclists spend 40\% more time in stores than motorists. This conclusion, in particular, was drawn by researchers from the Bartlett School of Planning, University College London and the Department of Transport of London. The study also observes that employees who cycle their way to work take sick leave 1.3 times less often than their colleagues. This saves the country’s economy £128 million annually\textsuperscript{18}.

The provision of compact and dense urban development and the diversity of land-use patterns in urban areas is conducive to the emergence of active transport modes among the population which boosts their motor activity. The promotion of walking and cycling and public transport, for instance, by improving the infrastructure operated by these transport modes, also encourages the development of active transport modes and motor activity. Fig. 1.13 illustrates possible strategies and key practices for sustainable urban land use and transport.

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\textsuperscript{18}http://content.tfl.gov.uk/walking-cycling-economic-benefits-summary-pack.pdf?fbclid=IwAR2OxnxBhqf0sW5CRSWvq_gWmTL1euolDlxtmk9-h5E6UHWo08H3N1VJyK
1.2 THE PEP and the implementation of the Agenda 2030

In 2002, in Geneva, the Transport Health Environment Pan-European Programme (THE PEP) was adopted with its governing bodies (the Steering Committee and its Bureau), the Secretariat as well as Focal Points in countries founded. The PEP High-level Meetings in in 2009 (held in Amsterdam) and in 2014 (held in Paris) adopted THE PEP objectives and endorsed the relevant Action Plans and Ministerial Declarations (Amsterdam and Paris Declarations). The next PEP High-level Meeting will be held in Vienna in October 2019.

The key challenges addressed by the activities of the THE PEP are the following:

- growing transport demand and excessive reliance on the use of private vehicles;
- the impact of transport-related air pollutants on human health and ecosystems;
- traffic congestion and the reduction of green spaces because of the lack of necessary coordination of transport and spatial planning;
- a rise in non-communicable diseases due to lack of physical activity and sedentary lifestyles.

The solutions proposed by the Programme are related to:

- integration of transport, health and environmental objectives into urban and spatial planning policies by improving collaboration, coordination and cooperation between all levels of relevant authorities;
- the development of public transport systems that are safe, clean, convenient, accessible, efficient and affordable;
- development of infrastructure, road signs and signals to ensure safe and healthy active mobility, in particular cycling and walking;
- mobility management schemes for work, school, leisure travel and other needs; development of eco-driving; introduction of new technologies
- the reduction of transport related GHG emissions, air pollutants and noise

The mechanisms for the implementation of THE PEP Programme are:

- THE PEP Relay-race Workshops (a series of seminars and conferences on issues related to Transport, Health and Environment in cities of the UNECE Member Countries to disseminate best practices and knowledge);
- development of national Action Plans on Transport, Health and Environment;
- THE PEP partnerships on singled out issues in line with the objectives of the Programme;
- development of THE PEP tools (guidance materials and practical recommendations);
- “THE PEP Academy” (a system of courses and curricula on Transport, Health and Environment, “summer schools”, etc.).

Between 2008 and 2018, THE PEP Relay Race workshops covered 14 cities in 10 countries with conferences and workshops held on topics such as “encouraging cycling and walking”, “sustainable urban and public transport”, “sustainable transport planning”, “innovation in transport”, “decarbonation and reduction of transport emissions”.

The Programme established 6 Member States partnerships on the topics of “eco-driving”, green and healthy jobs in transport, the integration of transport, health and environmental objectives into urban and spatial planning policies, the Transdanubian Partnership, health economic assessment tool for walking and cycling.\(^1\)

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\(^1\) Ongoing activities under the Programme and guidance documents made under the Programme are available at https://thepep.unece.org.
1.2.1 THE PEP and the SDGs

On 25 September 2015, at the United Nations Summit, the UN Member States adopted the 2030 Agenda for Sustainable Development which enshrined 17 Sustainable Development Goals. In the coming years throughout which these goals are to be achieved, all countries of the world must step up their efforts to tackle the issues of social protection, economic growth, environmental protection, ensure well-being for all, fight against inequality, etc. Almost all of the global Sustainable Development Goals (SDGs) are linked in one way or another to urban and transport planning and urban activities to improve the sustainability of transport systems.

Building a sustainable urban transport system involves planning its activities in conjunction with the economy, land use, urban planning, geography, ecology, sociology and psychology. Of the 17 global Sustainable Development Goals (SDGs), the following are related to sustainable development and urban transport systems (Figure 1.18).

Figure 1.16 The SDG targets most relevant to THE PEP priority goals

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20 https://www.un.org/sustainabledevelopment/ru/about/development-agenda/
1.2.2 The World Health Organization (WHO) Healthy Cities Initiative

WHO European Office Healthy Cities project got underway in 1986 in 11 European cities quickly expanding to other cities in the region. It was not long before the project went international as a way of implementing public health policy at the local level. The objectives of the project are being met through undertaking commitments at the political level which reflect devotion to the principles of “Health for All” and “Sustainable Development”.

A healthy city is one that is continually creating and improving those physical and social environments and expanding those community resources which enable people to mutually support each other in performing all the functions of life and developing to their maximum potential.

“Healthy cities” strive to create a healthy environment and ensure a high quality of life, sanitation and hygiene, and access to health care. Still, being included among the “healthy cities” does not depend on the existing health infrastructure in a city, but on the desire to improve urban infrastructure (including transport) and the willingness to establish the necessary ties and engage in interaction politically, economically and socially.

Figure 1.17 Factors affecting health

In conformity with the Healthy Cities approach, health issues should be prioritized on the political and social agenda of cities; a robust movement should be encouraged locally to support public health.

The concept of Healthy Cities was inspired and supported by the WHO European Health for All strategy and the Health targets. It is fully aligned with the European policy framework Health2020 and the 2030 Agenda for Sustainable Development.

The air quality model developed by WHO confirms that 92% of the world’s population lives in places where air quality levels go beyond “WHO Air quality guidelines” levels for annual mean particulate matter figures with a diameter of less than 2.5 micrometres (PM2.5).

There is a wide set of tools to be used to assess the public health impact of motor vehicles in urban projects (including within Healthy Cities):

1. Planning tools/methodological tools. The main tool is Health Impact Assessment (HIA). These tools are successfully combined with the Environmental Impact Assessment or Strategic environmental assessment (SEA);
2. Qualitative evaluation methods (interviews, focus groups, discussions with stakeholders);
3. Integrative analytical assessment methods that can be quantified and model actual or expected health effects. These include methods such as analysis of burden of disease,

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risk quantification and modelling. They are often used as combinations. Economic modelling (cost - benefit analysis and cost - effectiveness analysis) can be used to translate external costs, including those related to the mortality rate, disease and reduced productivity, into economic indicators.

4. Monitoring and evaluation tools often involve the use of indicators to track the achievement of the desired objectives.

Figure 1.18 Tools to assess the potential health impacts of transport policies

WHO’s most famous integrative analytical and quantitative tool is the Health Impact and Risks from Transport Systems (HEARTS) project. This project comprises three case studies designed to test models of quantitative analysis of the impacts of different urban land-use and transport policies on human health. Another WHO toolkit, HEAT, developed under THE PEP, serves to assess the health benefits of cycling and walking. The tool can be used to perform several types of assessment, and further explored in chapter 5.

In addition, WHO has established a Global Urban Ambient Air Pollution Database. The database provides an extensive information set on particulate matter air pollution (PM₁₀ and PM₂.₅) and contains indicators of more than 3,000 settlements whose population is ranges from 100 to more than 9,000,000 inhabitants.

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26 More detailed information on the HEARTS project is available at: http://www.who.int/cardiovascular_diseases/health/.

27 More detailed information on HEAT can be found at: http://www.euro.who.int/HEAT.

1.2.3 The United for Smart Sustainable Cities Initiative: a global initiative to join forces for smart and sustainable cities

The “United for Smart Sustainable Cities” (U4SSC) is a United Nations initiative coordinated by the International Telecommunication Union (ITU) and the United Nations Economic Commission for Europe (UNECE).

U4SSC serves as a global platform to advocate for public policy and to encourage the use of ICTs to facilitate and ease the transition to smart sustainable cities. It is supported by the Convention on Biological Diversity (CBD), the Economic Commission for Latin America and the Caribbean (ECLAC), the Food and Agriculture Organization (FAO), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Environment Programme (UN Environment), the United Nations Environment Programme Finance Initiative (UNEP-FI), the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Human Settlements Programme (UN-Habitat), the United Nations Industrial Development Organization (UNIDO), and the World Meteorological Organization (WMO) to achieve Sustainable Development Goal 11: “Make cities and human settlements inclusive, safe, resilient and sustainable.”

1.2.4 Principles of sustainable urban transport systems

In the light of the THE-PEP principles, the SDGs, the healthy cities initiative and the united smart cities initiative, we can determine a first series of basic principles for sustainable urban transport systems, based upon the following priorities:

- Primary focus on people and their needs;
- Improving the quality of life and meeting the needs of all people by ensuring equal, safe and equitable access to places, facilities, goods, services and other people;
- Ensuring a well-founded selection and alignment of all modes of urban transport and prioritising the use of the most environmentally friendly, safest and cleanest modes of transport and travel (pedestrians, cyclists, public transport, urban rail transport);
- Ensuring packages of quality measures and solutions are designed to deliver cost-effective results and promote sustained socio-economic growth;
- Use of intersectoral planning tools (effective integration of transport and urban planning, health, environment, energy efficiency, striking a balance between meeting the transport demand of society and economy and potential adverse impacts of transport activities, etc.);
- Meeting the needs of the economy in ensuring the timely and safe transportation of goods;
- Securing a reduction in the adverse impact of transport activities on the environment and human health;
- Engaging key stakeholders, the general public and local residents in the transport planning process;
- Ensuring the protection of the rights of both living and future generations.

A sustainable urban transport system should adequately deal with negative external and internal factors while serving its primary function i.e. providing mobility, including for disadvantaged and vulnerable groups which constitutes an integral component of the Millennium Development Goals.

The kinship between urbanization, rising motorization and the state of the environment derives from a number of factors in the complex system of socio-economic development and interaction between society and nature.

The new key message of modern urban environment development is bound up with the humanization of cities wherein they not only gain in convenience to accommodate people’s life, but also contributes to their professional fulfilment and expands their social and cultural scope.

In the past 15 years, the concept of quality and comfort of life in cities or in urban areas has come to be recognized as an essential criterion and, at the same time, as a problem of modern communities. The notion of a liveable city brings into focus such things as a home, a district and a city as a whole from the perspective of the conditions they provide to a person in terms of safety, economic opportunities, well-being, health, comfort, mobility, health services, education and recreation (Fig. 1.20).

Significant technological, economic and environmental changes, including climate change, economic restructuring, transition to online retail and entertainment, aging population, urban population growth and pressure on public funds have stimulated interest in “smart cities”.

Transport is essential to the “smart city” concept, a concept that implies the integration of information and communication technologies (ICT) and the Internet of Things (IoT solutions) as a way of bettering urban management and providing a high quality of life for people.

ICT enables city authorities to engage directly with communities and urban infrastructure, and to monitor what happens in the city, track the way the city is developing, and see what ways lead to the improvements in the quality of life. Urban infrastructure, including transport, energy, environmental protection and safety, is a major area of city intellectual activation. The advantages of urbanized “smart cities” areas are that they can offer users high-quality public transport and various infrastructure facilities within walking distance.

Nowadays, the basic idea of urban development is beginning to transform into making all the necessary benefits available to people. It is accessibility that is becoming the main goal of
transport systems that establish a necessary environment for fast and comfortable travel and effective mobility through “open” design and urban planning.

Figure 1.20. Healthy people in a livable city
Chapter 2. Spatial planning and urban mobility
Chapter 2. Spatial planning and urban mobility

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.

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

The shift towards a predominantly urban world has been formally assessed around 2005/7 (Peirce et al., 2006-8, Buchoud, 2008) but it took over a decade to start building multilateral regulatory frameworks. Meanwhile, local and regional governments, a wide range of stakeholders and interest groups from the civil society and the private sector have grasped change much more firmly than national governments. Urban growth has stirred unprecedented market-driven development opportunities in sectors such as smart cities, real estate development, creative industries which, up to a point, has blurred the lines between the general interest and the promotion of embodied interests (Peck, Tickell, 2002; Larner, Laurie 2010; McCann et al., 2013; Raco, 2013). The formation of new knowledge out of interdisciplinary strategies has been comparatively very slow (Revi et al., 2018) and weak.
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).

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.

There is a failure in the promotion of compact urban development models. 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. 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. 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. 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.\textsuperscript{x} 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.\textsuperscript{x}

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).\textsuperscript{x} 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.\textsuperscript{xi} 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?

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2.2 Inclusive urban planning, decision-making and strategy formulation

2.2.1 Principles

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 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.).

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.

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

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 series of measures:

- Development and implementation of information and telecommunication technologies ("information revolution", "digitalisation" of society and the transport sector);
- Development of “electromobility”, “smart mobility”, motorised transport shared use systems;
- Ensuring the emergence of automated driving vehicle 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 urban mobility strategy is to satisfy the travel needs of both people and businesses in such a way that it improves quality of life for the citizen and increases the competitiveness of a country or region. A successful urban mobility strategy needs to consider the interests of both public and private transport, passenger mobility and goods mobility, motorized and non-motorized transport and vehicles that are parked as well as those on the move. The establishment of a visionary and well-grounded urban mobility strategy requires careful consideration of a number of dimensions (figure 2.5).

UITP has identified four key dimensions to be considered by mobility actors in cities seeking to put in place sustainable urban mobility

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

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.

In reality, the replication and implementation of the aforementioned practices of the successful combination of urban and transport planning and measures for the creation and development of sustainable urban transport is hindered as decision-makers often have no clear idea of the desired agglomeration as a whole nor of its urban core, or their ideas are just too abstract to make it possible to premise specific transport policy objectives and develop a “Cities for People” strategy and concrete action plans on them.

If an urban mobility policy based on implementing the above four dimensions is to succeed in achieving its aims, it is vital that all four dimensions 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 (figure 2.6).

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 2.7 A tentative list of 25 imperatives to be considered by cities as a basis for defining sustainable urban mobility policies

<table>
<thead>
<tr>
<th>Core PT offering</th>
<th>Mobility Demand Management</th>
<th>Public Transport Financing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invest in a sustainable mobility offering and do not replicate mistakes of developed cities</td>
<td>Introduce and enforce parking policy as a critical instrument to steer mobility choices, while gradually increasing sophistication of fees and regulation structure</td>
<td>Drive demand for public transport to maximise fare revenue by focusing on gradual increases, set service offering quality and ensure transparency of fare adjustments</td>
</tr>
<tr>
<td>Establish a transparent, viable and stable regulatory framework for PT, integrating national and regional mobility objectives and ensuring clear allocation of duties and responsibilities</td>
<td>Define appropriate land-use policies to influence long-term mobility patterns and encourage travel-oriented development</td>
<td>Further individualize mobility offering by providing bundles of services targeting different customer groups at different prices</td>
</tr>
<tr>
<td>Professional PTG and formalize public transport</td>
<td>Introduce traffic calming measures to optimize streets usage conditions and increase quality of life for residents and businesses</td>
<td>Assess opportunities to exploit PT assets to derive additional revenues through aggregation of third party services</td>
</tr>
<tr>
<td>Develop an integrated approach for transport planning and other urban policies to shift from isolated decision-making toward integrated urban management</td>
<td>Introduce pricing measures to steer mobility demand through financial incentives and better synchronize supply and demand</td>
<td>Prioritize public funding for capital investments into projects with solid business cases demonstrating policy benefits and long term viability</td>
</tr>
<tr>
<td>Initiate fair competition between modes and business models</td>
<td>Encourage businesses to develop active corporate mobility strategy to increase mobility of individuals and goods while minimizing costs</td>
<td>Explore opportunities to perceive charges from indirect beneficiaries of PT and earmark them for PT financing</td>
</tr>
</tbody>
</table>

Cities in emerging countries with partly underdeveloped mobility systems: “Develop Sustainable Core”

Cities with high maturity and low share of public transport, walking, cycling: “Network the System”

Cities with high maturity and high share of PT, walking, cycling: “Network the System”
2.2.2 Sustainable Urban Mobility Plans (SUMP)

The development and implementation of Sustainable Urban Mobility Plans is fundamentally different from traditional transport planning. The full planning cycle of the SUMP encompasses four primary phases:

- Meticulous preparation of the planning process
- Transparent and rational goal-setting
- Development of the plan
- Fulfilment of the plan.

Figure 2.8. Designing Sustainable Urban Mobility Plans (SUMP)\(^\text{34}\)

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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 SUMPs. The final actions involve an evaluation of the process and the result in order to find the best solutions in the next SUMP.  

The implementation of SUMPs meets several types of barriers:

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

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

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

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

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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:

1. Increase quality of life and liveability;
2. Further improve accessibility;
3. Increase safety and minimize risk of accidents;

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 2.10 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.³⁶

Figure 2.11 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 2.11 bis 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.

³⁶ Based on the answers given by Basel (Switzerland) to the UNECE questionnaire.
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.37

### 2.2.3 Sustainability, mobility, accessibility

Within the new paradigm, the key concept associated with the sustainability of the transport system is not mobility (i.e. number and length of trips) but accessibility to individual locations and urban areas, accessibility to workplaces and recreational facilities, social and commercial infrastructure, accessibility of transport services i.e. the quality of life of the urban population (“Planning Cities For People, Not For Cars”). When put in perspective, accessibility can be regarded in different ways: physical accessibility, temporal accessibility, affordability, equal accessibility for certain categories of users (pedestrians, persons with reduced mobility, etc.), accessibility of urban areas and services (including transport-related ones), etc.

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 citizens1. However, planning practices remain too often an obstacle for accessibility policies, especially due to indirect incentives for urban sprawl. Figure 1.9. shows a classification of accessibility issues in cities.

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37 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](https://alatransit.kz/ru)
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.  

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,

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38 Based on the answers given by Basel (Switzerland) to the UNECE questionnaire.
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. 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 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 40.

**2.3.4 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 ICSER “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

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40 Based on the answers given by Basel (Switzerland) to the UNECE questionnaire.
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.

Fig. 2.14 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\(^{41}\).

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

\(^{41}\) Based on the answers given by Kazan (Russia) to the UNECE questionnaire.
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.

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 203342.

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 cycling43.

42 Based on the answers given by Kazan (Russia) to the UNECE questionnaire.
43 Based on the answers given by Tyumen (Russia) to the UNECE questionnaire.
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.44

44 According to the response of Moscow (Russia) to the UNECE questionnaire.
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.45

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45 According to the Green Mobility initiative, supported between 2013-2017 by the Nordic Council of Ministers (Copenhagen) which is being carried into effect by ICSER Leontief Centre (based in St.-Petersburg), www.mobility.leontief-centre.ru.
Figure 2.18  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

Figure 2.19 A long history of developing a livable city of Aarhus (Denmark)

With a population of 340,000 (2018), the city of Aarhus on the northeast coast is Denmark’s second-largest city and the fastest growing in the country. It is estimated that, over the next 15 years, the city should grow by 50,000 inhabitants and 30,000 work and study places. At the same time, Aarhus should be CO2-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.

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

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46 Based on the answers given by Strasbourg (France) to the UNECE questionnaire.
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 though 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\(^{47}\).

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\(^{48}\).

### 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\(^{49}\).

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:

- 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;

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\(^{47}\) According to the Green Mobility initiative, supported between 2013-2017 by the Nordic Council of Ministers (Copenhagen) which is being carried into effect by ICSER Leontief Centre (based in St.-Petersburg), [www.mobility.leontief-centre.ru](http://www.mobility.leontief-centre.ru).

\(^{48}\) Based on the answers given by Georgia to the UNECE questionnaire.

• 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\(^{50}\).

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\(^{51}\).

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

3. **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

\(^{50}\) 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.

constraint on it in another way. The capacity of parking spaces must be in line with the
density of the built-up area.\textsuperscript{52}

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 planning a new construction or the reconstruction of a building, a neighbourhood or a
residential area, a developer is meticulous to provide parking space for new residents and
provide easy access to and from their houses and neighbourhoods for 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.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure2.21}
\caption{Solutions to road network congestion}
\end{figure}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure2.22}
\caption{Sustainable Urban Mobility Plans (SUMP)}
\end{figure}

\textsuperscript{52} \url{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,
2.4.2 Urban freight traffic and city logistics

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.

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).

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 CO2 emissions and this is only expected to

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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. CO2/NOX 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 2.23 Key statistics - trucks, buses and coaches in the EU region

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

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

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.57

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57 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.
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.

Figure 2.25 “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 introduction of single parking space systems in cities helps address the issue of parking vehicles on the network of streets and roads in cities in a comprehensive way, reduce the time that cars spend in congested transport areas, boost the turnover of vehicles on parking lots and mitigate the peak pressure on roads.

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);
- 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.

57 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.

58 Based on the answers given by the Republic of Belarus to the UNECE questionnaire.
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.

The target level of parking rates is decided on by relying on the global practice in such a way as to ensure optimal occupancy of parking spaces. Normally, this figure stands at 85 percent.

By regulating the capacity of the single parking space, city authorities are able to implement a parking policy, including managing the demand for parking space and, accordingly, the traffic generated by private cars.

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.
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 outsources 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).

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 4.59

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

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).

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. Now, the city has 14 park and rides which in total can accommodate 1,559 cars located in Vyborgsky, Kalininsky, Kirovsky, Krasnogvardeysky, Moscovsky, Nevsky, Primorsky and Frunzensky districts.

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60 Based on the answers given by Tbilisi (Georgia) to the UNECE questionnaire.

61 Based on the answers given by the Republic of Belarus to the UNECE questionnaire.

62 https://www.gov.spb.ru, the official website of the Administration of St. Petersburg.


2.5.3 The key towards successful parking space management strategies

Pricing

Street parking tariffs

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 paths63.

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.

Drivers who travel around the surrounding area in search of free or inexpensive street parking often slow down the overall traffic flow. At the same time, those drivers who have already parked in free or low-cost places are likely to prefer to leave their cars for a considerable period, thereby adversely affecting the use rate (turnover) of parking spaces. These parking spaces could draw more customers to small and medium-sized businesses located in the area64.

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 2.30 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

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64 http://www.theregister.co.uk/2014/06/16/how_practical_is_an_electric_car_in_london/. 
residence are significantly different from the needs for visitors in transit. For instance, residents of London's administrative districts such as Camden and Islington pay for a home parking pass depending on the level of emissions discharged by their cars. Emissions are assessed in accordance with legally accepted standards when a vehicle is being registered.

Figure 2.31 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\(^{65}\) 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. Under this principle, supply remains stable without affecting the redevelopment and adaptation of the street structure for other purposes.

Motorists in most cases refrain from travelling to the central business areas of the city, except by certain modes of transport, such as vans owned by courier services.

**Introduction of a parking maximum limit**

The municipal authorities in a number of European cities have decided to introduce a parking maximum, setting a limit on the number of parking spaces to be determined in the areas under construction. Cities such as Zurich, Amsterdam and Strasbourg are the leading ones in the application of this measure, but in most cases the parking maximum limit is implemented relying on outdated construction codes, which have not been reviewed for decades. Countries such as Switzerland, Great Britain and Italy have adopted the regulations of parking maximum limits as state-level regulations.

As for the regulation of non-residential construction, the policy tends to be even more stringent. In this case, the parking maximum limit should take into account the local context of reducing car use, promote the development of cycling and pedestrian infrastructure and other conditions\(^{66}\). Despite the strict rules described in the document, its requirements are not legally binding.

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 Zürich 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 Zürich. 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**

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**

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.

The current trend in Europe is that street space becomes unprofitable for car owners. It is seen as a public asset that should be used more efficiently. In France, for example, underground parking was built in most cities to revive the streets and public spaces that had previously been crowded with cars parked in a chaotic manner.

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. 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 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

Technological progress in parking over the past couple of decades has enabled city authorities to ensure that parking policies are implemented in the most effective way. It has become easier for private companies to fulfil their contractual obligations by delivering high-quality services in respect of car owners abiding by parking regulations and collection of fees.

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

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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 2.33 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.

Continuously introduced technological innovations generate new opportunities for parking regulation and management. A growing majority of European cities are seen switching to multispace electronic parking terminals, which are more practical in terms of controlling the collection of fees from one parking space, as well as the regulation of the rate base. The maintenance costs of these terminals are not high. Also, most European cities provide a service where one can pay for parking via phone or via mobile application.

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.

In that context, it should also be noted that the implementation of new technological systems combined with contractualisation to private companies requires clear and transparent billing systems in order to prevent over-finising.
Chapter 3: Spatial planning and public transport
Chapter 3: Spatial planning and public transport

3.1. Integrated urban development policies across the UNECE region: the new hype?

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 21st 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.

Trends across UNECE region are too diverse to be summarized easily. In several countries across Europe, the response of spatial planning goes radically against private motor cars, whatever the energy they use but that’s far from being the new normal. In Scandinavian countries, the promoters of new development such as in Malmö, Gothenburg or Stockholm (Sweden) or Oslo (Norway) intensively communicate on the sustainable features of the new neighbourhoods. More generally across the EU, from Warsaw (Poland) to Lyon or Bordeaux (France), from Milano (Italy) to Birmingham or Manchester (UK), 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 and design proposals to alleviate traffic congestion, all across the country.

Wether urban masterplans across UNECE countries are being converted to become integrated urban development strategies with rolling investment plans would require additional fine grain research. There are encouraging indicators that the situation is about to change though. At the UN in Geneva, events such as the “urban week” or the “cities day” are well attended by a variety of quality urban stakeholders and they are becoming part of the rolling collective sustainable urban development agenda in Europe and beyond.

The implementation of the SDGs is another progressive game changer. The inclusion of the SDGs in municipal development strategies such as in Mannheim and the Rhein-Neckar MetropolRegion (Baden-Württemberg, Germany) remains seldom, but multilateral institutions such as OECD are supporting the territorialization of the SDGs as a matter of common interest for member states and local governments. UNECE is actively contributing to popularizing the issue of the SDGs for local and regional levels of governments and in cities throughout regional or inter-regional assessments and reports.

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 ATE

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or Association Transports et Environment are being joined by federal organisations to support “housing without cars” projects, growth and development priorities remain a priority in emerging economies. Designated “smart city” or mega-projects are rivalling in size and height. In Astana, the Abu Dhabi Plaza is a development of over 500,000sqm including a 75 storeys 230 m high new tower, nearly 30 more floors than the central feature of Tashkent City mega project currently under construction in the centre of Uzbekistan’s capital. 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 sophisticated R&D fuelled development projects such as in Amsterdam to more classical and yet rapidly changing planning norms such as in Nukus in the republic of Karakalpakstan (Uzbekistan), UNECE region definitely displays a wide array of nuances.

Europe’s urban landscapes at night as seen from the International Space Station shows how much urban scales are currently changing, with city, metro- and more continental scales interconnected if not mixed or merged in an infrastructure continuum where mobility and energy are central features. The long-awaited connectivity between urban master planning and transport master planning has never really happened and urban, transport planners are still belonging to very different professional’s spheres and yet, urbanization is a game changer for all, including beyond professionals, governments, the private sector and civil society players.

Inherited planning systems and norms, as well as transportation models, are challenged by systemic changes in the economy, the society, the environment and there is much progress yet to be made. Regardless of planning and mobility design and regulation systems, urban sprawl is happening all across UNECE countries. In EU countries alone, more than 72,000 km2, the equivalent of the size of Belgium and the Netherlands together are will have been built and urbanized between 2010 and 2030, according to current trends… (double check)
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 privat vehicle transportation, and by 4-1,000 times by using rail transport (including energy production)\(^69\)

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\(^70\).

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.\(^71\) 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.

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\(^{69}\) http://www.trafikdage.dk/t/d/papers/papers96/tr_og_em/kaleno/kaleno.pdf


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Figure 3.8 Emissions by mode of transport, including fuel production and delivery, as well as in traffic, g/pass-km.

**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 as the most universal kind, and also cycling as an addition to public transport).

**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 3.9 A comparison of the costs associated with arranging a 10-kilometre route with a peak passenger flow of 2,000 passengers per hour (source?)

<table>
<thead>
<tr>
<th>No</th>
<th>Indicator (with equal conditions of remuneration of labour and taxation)</th>
<th>Vehicle capacity</th>
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</thead>
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<tr>
<td></td>
<td></td>
<td>Low (Pori-Trans)</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Traffic frequency (the number of departures from a station per hour to service a flow of passengers of 2,000 passengers per hour)</td>
<td>91</td>
</tr>
<tr>
<td>3</td>
<td>Required fleet of rolling stock to service a route of 10 km at a given frequency</td>
<td>180</td>
</tr>
<tr>
<td>4</td>
<td>Rolling stock depreciation costs (including service life); min. rubles per year</td>
<td>86</td>
</tr>
<tr>
<td>5</td>
<td>Expenses on drivers (and fare inspectors for medium-capacity and high-capacity buses); min. rubles per year</td>
<td>183</td>
</tr>
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<td>6</td>
<td>Fuel and energy, min. rubles per year</td>
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</tr>
<tr>
<td>7</td>
<td>Rolling stock repair costs, min. rubles per year</td>
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</tr>
<tr>
<td>8</td>
<td>Infrastructure costs (maintenance and repair of a 3.5 km dedicated line, tramway; energy)</td>
<td>30</td>
</tr>
<tr>
<td>9</td>
<td>IN TOTAL: the maintenance costs of a 10-km route with a flow of 2,000 people per hour by mode of transport; min. rubles per year</td>
<td>462</td>
</tr>
<tr>
<td>10</td>
<td>Cost to minimum ratio (tram)</td>
<td>3.37</td>
</tr>
</tbody>
</table>

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. 3.1). 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 3.10 Number of road accidents caused by motorists per one passenger transported in the Russian Federation

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, 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.

**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.

The objectives of public transport vary depending on its function in urban transport, as shown in the figure below. 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 3.11 Possible level of quality standards for transport service given different levels of demand](image)

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

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72 https://www.uitp.org/news/knowledge-brief-LRT
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.

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 m² of floor area.

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.

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.

### 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 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.

Researchers point out that 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 a more ambitious goal.

**Definition of the transport network structure**

The basic principle of public transport is the concentration of passenger flows along a small number of routes. 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 planning.

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).

Figure 3.12 A network of feeder routes to the regional rail transport network, Wünsdorf (Germany) (attention: very old photos / example still relevant??)

Network effect74:

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.

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.

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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 large-capacity buses and 11 “Vityaz” articulated trams 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/m² of free floor area. 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.

To be completed by illustrations from other countries in UNECE region

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 3,9-4,000 passengers per hour, the frequency of extra-large capacity buses will exceed 30 crews 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 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.

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

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.

Figure 3.13 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 (source?)

<table>
<thead>
<tr>
<th>No</th>
<th>Indicator (with equal conditions of remuneration of labour and taxation)</th>
<th>Vehicle capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Low (Pesti-Tram)</td>
</tr>
<tr>
<td>1</td>
<td>Capacity, passengers</td>
<td>22</td>
</tr>
<tr>
<td>2</td>
<td>Traffic frequency (the number of departures from a station per hour) to serve a flow of passengers of 2,000 persons per hour</td>
<td>91</td>
</tr>
<tr>
<td>3</td>
<td>Required fleet of rolling stock to serve a route of 10 km at a given frequency</td>
<td>180</td>
</tr>
<tr>
<td>4</td>
<td>Rolling stock depreciation costs (including service life, mesh, interval per year)</td>
<td>86</td>
</tr>
<tr>
<td>5</td>
<td>Extending on elevators (and fare inspectors for medium-capacity and high-capacity buses) min. rubles per year</td>
<td>183</td>
</tr>
<tr>
<td>6</td>
<td>Fuel and energy, min. rubles per year</td>
<td>49</td>
</tr>
<tr>
<td>7</td>
<td>Rolling stock repair costs, min. rubles per year</td>
<td>115</td>
</tr>
<tr>
<td>8</td>
<td>Infrastructure costs (maintenance and repair of a 3.3-m dedicated lane, tramway, energy)</td>
<td>30</td>
</tr>
<tr>
<td>9</td>
<td>IN TOTAL: the maintenance costs of a 10-km route with a flow of 2,000 people per hour by mode of transport, min. rubles per year</td>
<td>462</td>
</tr>
<tr>
<td>10</td>
<td>Cost to minimum ratio (tram)</td>
<td>-3.37</td>
</tr>
</tbody>
</table>

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).

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.

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, as well as, if possible, arrivals of transport vehicles common stopping station at intersections.

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.

Figure 3.14 Minimum walking distance represented in the practice of efficient Freiburg’s interchange hubs (terribly old photos...)

Interchange hubs for "seamless" transfers in Freiburg (Germany), (Fig. 3.14): main railway station; main hub of tram lines (designed in conjunction with the pedestrian area for easy transition between routes), transfers from suburban feeder buses to trams; park-and-rides ensuring transfers to the tram outside the city centre.

As can be seen from the given examples, the walking distance is minimised in each case. A passenger simply needs to go downstairs or use an elevator at the station; a passenger simply needs to cross two tramlines to make a transfer at the city centre square; when making a transfer from suburban buses, passengers arrive at the same platform as the tram headed for the centre so a passenger needs to walk 4-5 metres (the width of the platform) in order to make a transfer.
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.

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 cyclists 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 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 single tickets used in the metro as well as delivering high-frequency
service, 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. The system operates during the day and integrates rail transport into citywide transport to serve as an interchange hub to facilitate transfers.

Figure 3.16 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)

Similarly, 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 network 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.

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, Fig. 3.11) 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 best 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.
3.2.6 Case studies and good practices

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

Between 1980 and 1990, the share of public transport in Zurich increased not only in the city centre but also in the suburbs and outskirts, which stands in contrast with most other European cities where private vehicle transportation in the suburbs is growing much faster than public transportation (Figure 3.12).

**Figure 3.17 Share of public transport among motorised journeys in European cities (source?)**

<table>
<thead>
<tr>
<th>City</th>
<th>Share of public transport</th>
<th>Relevant year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zürich</td>
<td>57%</td>
<td>1992</td>
</tr>
<tr>
<td>Helsinki</td>
<td>40%</td>
<td>2000</td>
</tr>
<tr>
<td>Frankfurt</td>
<td>39%</td>
<td>1998</td>
</tr>
<tr>
<td>Munich</td>
<td>37%</td>
<td>1997</td>
</tr>
<tr>
<td>Oslo</td>
<td>37%</td>
<td>2000</td>
</tr>
<tr>
<td>Freiburg</td>
<td>35%</td>
<td>1998</td>
</tr>
<tr>
<td>Karlsruhe</td>
<td>27%</td>
<td>1992</td>
</tr>
<tr>
<td>Gothenburg</td>
<td>24%</td>
<td>2000</td>
</tr>
</tbody>
</table>

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. 3.14) 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 3.18 Changes in the level of motorisation and mobility of population as regards PT use in Zurich and Frankfurt between 1970-1998 (is this relevant cf dates?)**
A comparison of service density shows that the service area of Zurich is about 3 times bigger than that of Bochum.

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.
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 (Fig. 3.17). This was achieved by implementing a number of necessary measures, namely, traffic management and traffic light cycles introduced with priority given to public transport (Fig. 3.18), dedicated lanes and road sections for public transport traffic only (Fig. 19), optimised location of stopping points, informing passengers on the location of buses en route by electronic displays in real time.

![Figure 3.22 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)](image)

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
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. 3.22).
Figure 3.23 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.

Fig. 3.24 Copenhagen (Denmark). Left: S-bus (suburban express), right: A bus (main-line city bus, 3-5-minute interval during the day)

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 (Figure 3.23). In the late evening, buses are replaced by taxis to match the level of demand.

Figure 3.25-3.26 In the city of Lemgo (Germany) a unified style, unified information support and coordinated timed schedule have been developed for city buses (source of the photos?)

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 (Fig. 3.24).
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.

![Image of bollards in Cambridge](image)

*Figure 3.27 In Cambridge (UK), bollards serve to block entrance into the city centre for all modes of transport except PT and service vehicles (photos ... ©...)*
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 (Fig. 3.26).

Figure 3.28 An example of evaluating urban transport policy measures for decision-making in the city of Edinburgh (UK) (source? Date?)

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

Strasbourg, France: the experience of altering the transport policy following an evaluation. The new tram system of Strasbourg has changed the urban environment and the transport accessibility for shopping streets in the city centre. A comparison of the situation “before and after” (Fig. 3.27) reveals how greatly the passenger flow has increased in the shopping streets of Strasbourg following the ban on road traffic and the introduction of a tram-pedestrian street.

Figure 3.29 In Strasbourg (France), the ban on road traffic and the introduction of a tram-pedestrian street in the city centre has significantly boosted the influx of visitors to the stores located in the city centre (photos … ⊕...
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 (Fig. 3.28). An example from Trondheim (Norway) is presented below (Figure 3.29). Concentrating jobs in Zone A will maximise the demand for public transport while reducing the demand for private vehicles.

Figure 3.30 -3.31 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 (Fig. 3.30). 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 3.32. 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.

In a number of Russian cities, 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.

Figure 3.34. 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).
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 (Fig. 3.42). 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 3.35 Moscow (Russia). The scheme of the Magistral route network in the Moscow centre is simple, understandable and convenient for passengers.
3.3 Financing public transport

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 3.38).

Figure 3.36 An analysis of differences in terms of the transport policy between the UK and France (still relevant as of 2019?)*

<table>
<thead>
<tr>
<th>United-Kingdom</th>
<th>France</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective:</strong> improve the efficiency of transport systems by reducing road congestion</td>
<td><strong>Objective:</strong> develop liveable cities by replacing private vehicles with alternative modes of transport</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Political context</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td>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.</td>
</tr>
</tbody>
</table>

| 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. |

<table>
<thead>
<tr>
<th>Characteristics of LRT projects</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Provides regional transportation along commuter “suburb - agglomeration centre” routes.</td>
<td>Improves primarily urban transportation in the agglomeration centre with less focus on the suburbs.</td>
</tr>
</tbody>
</table>

| There is no relation between LRT projects and the private vehicle use reduction | LRT projects are coordinated with measures to reduce vehicle use |

---

<table>
<thead>
<tr>
<th><strong>policy</strong></th>
<th><strong>Generally, a completely new LRT infrastructure: measures to revitalise streets along the LRT corridor cost up to 50% of the overall LRT construction expenses</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>In many cases, the use of the existing railway (currently unutilised) infrastructure and its corridors for laying out routes for LRT</td>
<td>Minimising budget financing and risks by involving private capital</td>
</tr>
<tr>
<td></td>
<td>Completely budget financing</td>
</tr>
<tr>
<td></td>
<td>A long period from initial works to commissioning</td>
</tr>
<tr>
<td></td>
<td>Typically, just a few years from the proposal phase to commissioning works</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Common features</strong></th>
<th><strong>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.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cities for analysis</strong></td>
<td>Manchester, Sheffield, Birmingham, Croydon</td>
</tr>
<tr>
<td></td>
<td>Lyon, Marseille, Montpellier</td>
</tr>
</tbody>
</table>

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. The results of the expert survey are shown below.

Figure 3.37 Key factors in achieving success in urban transport systems development. The maximum score corresponds to the most important factor of success (very old source!!)

<table>
<thead>
<tr>
<th>Key factor</th>
<th>Point</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Political or structural factors</strong></td>
<td></td>
</tr>
<tr>
<td>Regional management of the transport system</td>
<td>28</td>
</tr>
<tr>
<td>Political consensus</td>
<td>9</td>
</tr>
<tr>
<td>Public support</td>
<td>9</td>
</tr>
<tr>
<td>Political leader</td>
<td>7</td>
</tr>
<tr>
<td>Administration and control by the central government</td>
<td>4</td>
</tr>
<tr>
<td>Stable political situation</td>
<td>10</td>
</tr>
<tr>
<td><strong>Transport policy</strong></td>
<td></td>
</tr>
<tr>
<td>Infrastructure investments or subsidies</td>
<td>29</td>
</tr>
<tr>
<td>Competitive procurement process in place to select an operator for a route</td>
<td>19</td>
</tr>
<tr>
<td>Parking restrictions (paid parking)</td>
<td>9</td>
</tr>
<tr>
<td>Integration of transport and land use</td>
<td>16</td>
</tr>
<tr>
<td>Low fares for public transport</td>
<td>13</td>
</tr>
<tr>
<td>Integrated tariff and ticket system</td>
<td>32</td>
</tr>
</tbody>
</table>

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).

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The level of subsidies for public transport varies widely across cities around the world. Data on the level of subsidies are shown below. (source???)

Figure 3.40. 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, whereas the net cost contract implies that all revenues are collected by the operator 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 level of growth). This is the case in New Zealand. It should be noted that with integrated planning, such decisive factors as the schedule, frequency, route roads are already defined 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.

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.
Chapter 4. Mobility and urban transport policies: shifting to an environmental focus?
Chapter 4. Mobility and urban transport policies: shifting to an environmental focus?

4.1 From co-modality to bicycle superhighways

4.1.1 Co-modality, intermodality, and the development of cycling as an example of active mobility mode

"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."77

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.

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

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77 Copenhagenize. Mikael Colville-Andersen
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 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.

Figure 4.2. 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.

Figure 4.3 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 km². 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 m²)
• 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).

4.1.2 Bicycle superhighways: a generation of integrated cycle infrastructures

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.

Figure 4.4 the project of bicycle superhighway in the Ruhr Region (Germany)

In 2015, the German Federal Ministry of transport (verifier) 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.»\textsuperscript{79} This project is targeting to pull over 50,000 cars off the roads.

Similar initiatives are also under way in other parts of Germany, be it Münich 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.

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

\textsuperscript{79} Kelly Mc Cartney, Ecowatch, July 2016
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)
- 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).

4.2 Sharing mobility: urban car sharing systems, carpooling, ridesharing, bicycle sharing systems

Sharing economy an issue popularized a decade ago, is a game changer in the field of mobility\textsuperscript{80}, based on the collective use of goods and services, barter and lease instead of ownership. The audit company 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. However, one recurrent controversial issue behind sharing economy is that businesses that build on the collaborative consumption model come under criticism for ignoring the contradictions between self-sufficient small transactions and the global corporations that manage them, violation of labour rights, circumvention of state regulation and tax evasion.

4.2.1 Car sharing

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 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).

\textsuperscript{80} What's Mine is Yours: The Rise of Collaborative Consumption. Rachel Botsman and Roo Rogers, 2010
Introducing mechanisms of collaborative consumption in the transport sector may initially not produce a proper social effect and, on the contrary, lead to certain negative outcomes while public awareness about it is being raised. For instance, the introduction of measures to regulate the access of cars to certain urban areas and other measures pursued by the city authorities aimed at discouraging the use of privately owned cars may, in some cases, encourage increased use of shared motorised transport services without users giving up on their own vehicles. The lack of adequate legal regulation in place to govern the activities of operators of online platforms may cause a legal vacuum in transport safety along with an increase in the road accident rate.

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 year81.

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.

In Figure 4.5, car sharing business models82

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The fleet of car sharing companies range from dozens to thousands of cars in major cities. All the locations where the cars are parked can be viewed via the mobile app or on the website of the car sharing operator.

A driver can take and leave a car in one of these parking lots. The key strength of car sharing is the short-term nature of car rental. A driver can take a car for any period of time charged by the minute for actually using the car, for example, when a person is running late and they just need to drive a couple of streets. The user is charged per the time spent in travel and idle time with refuelling costs covered by the car sharing operator. As a result, an individual gets a private car for a short period of time, which only takes a mobile application installed on their phone with a bank card tied to the app.

Figure 4.6. A global mapping of B2C car sharing platforms in the world in 2015/2016

Implementing car sharing models, however, is not without difficulties. 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 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.

Figure 4.7 The Autolib' experience in Paris and Paris metro area: a complex public-private organisation

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 imanaging 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 no using the electric charging points of the former Autolib' system.

Figure 4.8 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

84 Illustration source: L'Express.fr / vivrelemarais.typepad.fr
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;
- 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\(^{85}\).

### 4.2.2 Car-pooling and ride-sharing

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.

![Figure 4.9 The official inauguration of car-pooling parkings in Manosque and Peyruis (Haute Provence, France)\(^{86}\)](image_url)

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.\(^{87}\) 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.

\(^{85}\) [http://voditeliauto.ru/poleznaya-informaciya/online/carsharing.html](http://voditeliauto.ru/poleznaya-informaciya/online/carsharing.html) as well as based on the answers given by Moscow (Russia) to the UNECE questionnaire.

\(^{86}\) Source: Haute Provence info, April 2013

\(^{87}\) 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.
Typical carpooling benefits

- Savings on fuel, repair, parking and fees;
- Reduced traffic congestion thanks to car enthusiasts and fellow traveller riding together in one car;
- Reduction of emissions of pollutants and climate gases;
- Avoiding stress and driving load. Taking turns day-by-day allows carpooling users to alternate in driving;
- 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.

Typical carpooling weaknesses

- The driver is responsible for the delay should his/her car vehicle involved in a car accident;
- Drivers sometimes have to come and pick up their passengers which extends their travel time;
- It is hard for municipal authorities to organize and support the operation of carpooling;
- Risk of riding with a fellow traveller with criminal intent.

4.2.3 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. 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.

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 CO2 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 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

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88 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/.

89 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
more following the same fate. Meanwhile, the rest of the world follows the roller-coaster fate of Chinese free floating bikes.

Figure 4.12 The introduction of the GoBike free-floating system in Almetyevsk in 2017 (Russia, Republic of Tatarstan) 90

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 services91 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 ridership92.

Figure 4.13 The city mayor of Paris and the president of Paris metropolitan authority in a show to publicize the new Vélib’ bikes in 201893

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. 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.

Many of the most successful systems share certain 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.

### 4.3 Electromobility

#### 4.3.1 Electric MRT in cities

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.

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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. (source)

The regional-level transport impact (from several hundred to several thousand kilometres) on the environment includes:

- emissions of pollutants aggravating precipitation acidification and eutrophication of water bodies: sulphur dioxide SO2 and nitrogen dioxide NO2;
- environmental effects coming from extraction, processing and consumption of material and energy resources, both renewable and non-renewable;
- unintentional transport of living organisms with persons or goods in transit or in the structure components of vehicles leading to the introduction of these organisms into ecosystems not adapted to their existence.

The most obvious of transport impacts on the environment and human health is seen locally as all transport activities begin and end (and are carried out, in many cases) in places of residence and economic activity of people.

Most studies break down the life-cycle assessment of vehicles into four stages.

**Figure 4.15. Typical life cycle of the construction of a vehicle**

<table>
<thead>
<tr>
<th>Main stages</th>
<th>Stage composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel production</td>
<td>Extraction and transportation of raw materials; construction of processing plants; fuel technological production process; fuel distribution; refuelling of vehicles.</td>
</tr>
<tr>
<td>Manufacture of vehicles</td>
<td>Extraction, transportation and processing of raw materials; processing of raw materials; construction of plants; production of components; transportation of components, assembly, distribution of vehicles, disposal/recycling/waste burial</td>
</tr>
<tr>
<td>Operation of vehicles</td>
<td>Mileage (specific) emissions taking into account operational features, age, etc.</td>
</tr>
<tr>
<td>Maintenance, repair and service of vehicles</td>
<td>Production of components; distribution; construction of infrastructure, maintenance.</td>
</tr>
<tr>
<td>Recycling / scrapping / burial of vehicles</td>
<td>Collection of vehicles out of service, disassembly, sorting of spare parts and materials, recycling/scrapping/burial of materials.</td>
</tr>
</tbody>
</table>

Energy generation techniques are important for life cycle assessments. Studies (source) aimed at life cycle assessments usually draw on the concept of “generating mix”. This concept implies the calculation of the share of different sources of electricity production (generation) (hydro, thermal, nuclear, wind, solar power plants, etc.) in the country for which the study is being conducted.

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.

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).

The electric transport operated in cities includes:

- public rail electric transport (tram (LRT), metro, urban and suburban commuter trains);
- urban public non-rail electric transport (trolleybus, electric bus);
- other types of public electric transport (funicular, monorail, cable car);

• electric vehicles and cars that run on hybrid propulsion systems;
• small electric mobility means (electric bicycle, electric scooter, gyroscooter, etc.).
• Electric transport - tram (LRT), trolleybus, electric bus, metro, funicular monorail, cable car, string transport, urban and suburban commuter trains.

The modern world practice (for instance, the practice of the International Association of Public Transport) views the trolleybus as an electric type of bus while increasingly regarding the tram (light rail transport, LRT) as metro. The type of (electric) traction 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 (source?) 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 development of tram and trolleybus does not mean buses have no future. 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. 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)\(^96\). As compared to road transport, rail transport has several advantages: \(^97\)

- higher carrying capacity;
- reduced need for passenger transportation areas;
- 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);
- higher traffic safety (less manoeuvres, no others vehicles on the road).

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 Bucharest 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\(^98\), 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\(^99\). 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

\(^{96}\) journal “Tekhnika zheleznykh dorog” (Railway Engineering), No. 4 (36), by S.S. Zakirova, V.A. Matrosova, E.V. Matveeva “The situation with urban electric transport in Russia”.

\(^{97}\) http://mapget.ru/strategy/rol-get/

\(^{98}\) According to the response of Moscow (Russia) to the UNECE questionnaire.

\(^{99}\) Based on the answers given by Basel (Switzerland) to the UNECE questionnaire. www.klybeckplus.ch
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.

Figure 4.16 The development of a new generation of tramway, now all over UNECE region
4.3.2 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. However, UNECE countries, along with India have demonstrated an increase in the fleet of electric buses and electric-drive two-wheeled vehicles.

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.

Electric buses already offer a better total cost of ownership (TCO) than diesel buses when these external costs are included. (source?) When only health costs are considered (air quality and noise), electric buses are roughly on parity with diesel buses. (why?)

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.

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. In Paris, RATP, the company operating public transportation, has recently (April 2019) introduced experimental autonomous parking systems in buses depots while developing a fleet of hybrid vehicles.

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100 According to the response of Moscow (Russia) to the UNECE questionnaire.
4.3.3 Electric cars, another game changer in the industry (and for sustainable mobility?)

The development of electric cars is another major change that is affecting 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.\(^{101}\)

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.\(^{102}\) 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.

Figure 4.18 The rise of electric vehicle sales\(^{103}\)

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.

4.19 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.

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\(^{103}\) Presentation by Michael P. Walsh, International Consultant, Founding Chairman Board of Directors, International Council on Clean Transportation, Moscow, Russia, May 19, 2017.
According to IEA, electric vehicles charging infrastructures are expanding rapidly: the number of EV charging points has increased to 3,000,000 all over the world, of which about 430,000 units are publicly available, and about a quarter are equipped with fast chargers.

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 CO₂/ 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 positive factors for the European economy linked with EV development, encouraging electric cars to become the new normal:

- 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.

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The impact of the conversion of the car making industry to electric vehicles is being intensively debated. According to the European Commission (source?), 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.

106 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.
chargers across Europe. More than 90% of new EV sales are in Northern and Western European countries where 80% of planned public charging points will be concentrated.

Figure 4.24 Impacts 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 (source?) 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.

Figure 4.25 Electric cars have lower total costs of ownership (source of graph?)

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.

More recent studies are even more positive, with EVs already cheaper to own and run in the UK, Japan and US markets with current incentives. For the second and third owners EVs are substantially cheaper with much lower operating and maintenance costs.

The rapid decline in battery prices and technology is continuing with cell prices expected to drop further. The price of lithium-ion batteries is dropping rapidly and is expected to drop by another third by 2025, making EVs competitive on purchase price by 2025.

While electric cars have zero tailpipe (or tank-to-wheel) emissions, there are upstream emissions from manufacturing the battery and from electricity generation. But analyses of full life cycle C02 consistently show on average battery electric vehicles emit less C02 over their lifetime than diesel cars. A meta-analysis of 11 independent LCA studies done in recent years concludes that a battery electric car over its lifetime produces 50% less C02 emissions than an average EU car today.

In Europe, when the latest grid intensity figures are taken, even a EV charged on Polish electricity produces 25% less C02 than a diesel car. As the EU power sector decarbonises the benefit over oil becomes ever greater. Battery cell manufacturing today is largely in China and South Korea but as the market expands so does production into Europe, where the electricity is less carbon intensive reducing emissions by 65%. At least 5 gigafactories are already
planned by early 2020s addressing the environmental concerns of cell manufacturing and creating jobs.

### 4.4.4 EV technology and sustainable mobility

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 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 107.

### 4.4.5 Bigger and smaller. Electromobility by all means of transportation

Several experiments of electric motorways for trucks are being developed in several countries such as Sweden or Germany along with truck companies. The images of electric or hybrid semi-autonomous or entirely autonomous trucks cruising without using fossil fuel and emitting CO2 and other particles are striking but such combinations still remain tentative. Besides, truck manufacturers have entered into competition at a global scale to produce e-trucks, following what happened in the last decade with cars, small trucks (delivery vehicles) and more recently with buses.

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107 [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  
108 source. Scania.com
At the other end of the mobility chain, cities across the world (and hence, in UNECE region) have experienced a rapid growth in the use of “small” electro mobility devices of all sorts, such as electric scooters, electric bicycles, Segways, gyroscoters, 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.

Figure 4.27 Tentative list of most common individual E-Mobility vehicles and devices

<table>
<thead>
<tr>
<th>Device</th>
<th>Definition</th>
<th>Use</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electro bikes</td>
<td>Electric powered motorbikes</td>
<td>Same as a regular motorbike</td>
<td>Range: 50-100 km Max speed: same as a motorbike km/h</td>
</tr>
<tr>
<td>Electric bicycle</td>
<td>A bicycle equipped with an electric drive that partially or completely propels it</td>
<td>Same as a regular bicycle. Requires no driving licence or license-plate number. May be operated by people of different ages and health status</td>
<td>Range: 25 - 50 km (rarely up to 100 km). Weight: 20 - 50 kg. Max speed: generally, up to 50 - 60 km/h</td>
</tr>
<tr>
<td>Monowheel (unicycle)</td>
<td>Electric self-balancing scooter with a single wheel and two stands.</td>
<td>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</td>
<td>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</td>
</tr>
<tr>
<td>Gyroscooter</td>
<td>Self-balancing scooter, private electric vehicle. Different from the segway in that it has no steering column</td>
<td>banned from use on roads and sidewalks in a number of countries</td>
<td>Possible injuries in the event of a fall</td>
</tr>
<tr>
<td>Segway</td>
<td>Electric self-balancing vehicle equipped with 2 wheels on both sides of the driver</td>
<td>Can move on asphalt and soil. Used by police, postal workers. Fairly fast and manoeuvrable</td>
<td>Fairly expensive. Weight: approx. 40 kg. Mileage: up to 39 km Maximum speed: up to 50 km/h</td>
</tr>
<tr>
<td>TWIKE</td>
<td>Human-electric hybrid vehicle. Three-wheeled electric vehicle with an additional pedal drive. Sometimes viewed as a light electric vehicle</td>
<td>Operated on the road</td>
<td>Speed: up to 85 km/h Range: up to 150 km/h (without pedalling) Weight: approx. 250 kg</td>
</tr>
<tr>
<td>Tricyclopod</td>
<td>Three-wheeled motorised (usually electric) vehicle operated by one person in a standing position</td>
<td>Designed for short local trips on flat urban roads and sidewalks, shopping, police officers on patrol</td>
<td>Speed: 25-40 km/h</td>
</tr>
</tbody>
</table>
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. 110

A 2016 PriceWaterhouseCoopers (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. 111
Chapter 5. Urban transport systems, health and quality of life
Chapter 5. Urban transport systems, health and quality of life

5.1 Interlinkages between urban transport and health

5.1.1 Time spent in transport and factors influencing consumer’s choices

**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 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.\(^{112}\)

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.

\(^{112}\) 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.
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 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 carries 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.

Figure 5.1. Total time spent on travel
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.\textsuperscript{113}

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 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 \textit{(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.

\textsuperscript{113} 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).
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 5.2 presents a diagram which shows the relationship between direct passenger benefits, improvements in road traffic conditions and broader economic consequences presented by French scientist Venables (2015)\textsuperscript{114}.

5.1.2 Pollution and physical 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\textsubscript{2} (Fig. 5.3) 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 (Fig. 5.4), but also on the quality of the motor fuels used (most importantly, sulphur content), as well as the technical condition of vehicles in operation.

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 hydrocarbons115. The transport pollutants emitted cause both local exposures (CO, hydrocarbons) and local and more global (regional, interregional) effects (NOx, SOx, PM).

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 (SO2), 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 PM2.5 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.

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);

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• 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. According to WHO experts, over 600,000 people annually fall victim to sedentary lifestyles in Europe and Central Asia. Over time, hypodynamia leads to bone mass loss, articular and spinal degradation; reduced lung capacity and pulmonary ventilation. Hypodynamia is one of the causes of obesity, diabetes and depression. With Melbourne used as an example, researchers from Australia showed that travelling by car costs society 19 times more than cycling (Fig. 5.5).

Figure 5.5. A study conducted in Australia used Melbourne as the premise for a comparison of cycling costs against motor vehicle use costs

![TOTAL SOCIETAL COST OF COMMUTING](https://example.com/total_cost.png)

**Total cost to society per trip**

- **Driving**: $52.7
- **Train**: $30.6
- **Cycling**: $2.8

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.  

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117 [http://blog.deloitte.com.au/divorcing-growth-car/?fbclid=IwAR059hS_5eSGJ-LU9KkV57QGkS9hpy_nV56R6NX1_THK80eCmQzzqQAhvw](http://blog.deloitte.com.au/divorcing-growth-car/?fbclid=IwAR059hS_5eSGJ-LU9KkV57QGkS9hpy_nV56R6NX1_THK80eCmQzzqQAhvw)

118 [https://ajph.aphapublications.org/doi/abs/10.2105/AJPH.2015.302724?journalCode=ajph&fbclid=IwAR3RJeLUt6op0piF9lh4LzyBzu8NwKgp063UkXn2Ar852377JNQTXtKjSjg](https://ajph.aphapublications.org/doi/abs/10.2105/AJPH.2015.302724?journalCode=ajph&fbclid=IwAR3RJeLUt6op0piF9lh4LzyBzu8NwKgp063UkXn2Ar852377JNQTXtKjSjg), American Public Health Association — Dutch Cycling: Quantifying the Health and Related Economic Benefits
5.1.3 Traffic accidents

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. The 2030 Agenda for Sustainable Development sets out an ambitious objective: By 2020, halve the number of global deaths and injuries from road traffic accidents.

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.

![Maximum national speed limit on urban roads](image)

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.

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.

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121 From a presentation of Anthony D. May, Professor of Transport Engineering, University of Leeds, UK.
Speed control measures include the following:

- Construction or re-construction of roads with traffic-restraining components added such as roundabouts and artificial elevations;
- speed limits to be established as per the functional purpose of each road;
- enforcing compliance with speed limits through the use of manual and automated control measures;
- equipping new vehicles with on-board technologies such as allowed speed maintenance and autonomous emergency braking technologies;
- raising awareness about the dangers and hazards of speeding.

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 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.

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.

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Figure 5.7 Principles, core elements, and action areas of the “Safe System” approach[^2]

<table>
<thead>
<tr>
<th>PRINCIPLES</th>
<th>CORE ELEMENTS</th>
<th>ACTION AREAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humans Make Errors</td>
<td>Economic Analysis J</td>
<td>Land Use Planning</td>
</tr>
<tr>
<td>Humans Are Vulnerable to Injury</td>
<td>Priorities and Planning</td>
<td>Improved Mobility Options</td>
</tr>
<tr>
<td>Responsibility Is Shared</td>
<td>Monitoring and Evaluation</td>
<td>Enforcement Laws and Regulation</td>
</tr>
<tr>
<td>No Death or Serious Injury is Acceptable</td>
<td>Comprehensive Governance and Management</td>
<td>Vehicle Design and Technology</td>
</tr>
<tr>
<td>Proactive vs. Reactive</td>
<td>Strong Targets and Data</td>
<td>Post-crash Emergency Response and Care</td>
</tr>
</tbody>
</table>

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 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 responsibility123.

5.1.5 Case studies and good practices

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.

The purpose of the new Road Traffic Act adopter 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.

![Figure 5.8 A new road and traffic act in Finland. (all weather biking in Oulu)](image)

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)124.


124 According to Finland’s response to the UNECE questionnaire.
France is experiencing several initiatives to promote walk, such as the walking buses to school or the pedestrian’s signs including walking time.

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 cites. 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 scheme125.

Figure 5.9 Cycling, also in Moscow (Russian Federation)

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,
- 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 space126.

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”.

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125 Based on the answers given by France to the UNECE questionnaire.
126 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
Figure 5.10 The programme on Promotion of cycling and cycling infrastructures in Almetyevsk (Russia, Republic of Tatarstan)

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.127

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).128

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.129

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.130

Illustration 5.11 Sweden has launched a program called “Vizion Zero” targeting zero deaths on the roads

While Vision Zero has 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. 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 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

127 Based on the answers given by Almetyevsk (Russia, the Republic of Tatarstan) to the UNECE questionnaire.
128 Based on the answers given by Tuymen (Russia) to the UNECE questionnaire.
129 Glonass is a Russian equivalent to Galileou (Europe) and GPS (United States) satellite positioning systems.
130 Based on the answers given by Almetyevsk (Russia, the Republic of Tatarstan) to the UNECE questionnaire.
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.

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.\footnote{According to the Green Mobility initiative, supported between 2013-2017 by the Nordic Council of Ministers (Copenhagen) which is being carried into effect by ICSER Leontief Centre (based in St.-Petersburg), \url{www.mobility.leontief-centre.ru}.}

## 5.2 Active Mobility and Health

### 5.2.1 Physical Activity and Human Health

The WHO recommends a minimum of 150 minutes of moderate intensity, aerobic physical activity for adults per week. Statistics\footnote{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 PA 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.

### 5.2.2 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 liveable cities. One of the central components of Sustainable Urban Mobility Plans (SUMPs) 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.

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.

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.

5.2.3 Enabling factors, Barriers and Challenges for Active Mobility

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.

5.2.4 The Link Between Health and Active Mobility

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.

Illustration 5.13 The Health Economic Assessment (HEAT) Tool

The 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 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

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133http://letsbikeit.ru/2015/02/copenhagen-cycling-innovation/
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.

Illustration 5.14 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 Activity (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.
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 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.
- Second After-Engagement Survey: 4-6 months after the campaign, measure long-term behavioral change.
Donosita/San Sebastian is an example of a city that successfully implemented the SWITCH program. The city is the capital of the Gipokuza 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 Donosita. 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.

<table>
<thead>
<tr>
<th>Results</th>
<th>Before the campaign</th>
<th>Shortly after the campaign</th>
<th>3 months after the campaign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>532</td>
<td>490</td>
<td>471</td>
</tr>
<tr>
<td>Car use</td>
<td>21.6%</td>
<td>21.1%</td>
<td>9%</td>
</tr>
<tr>
<td>Cycling</td>
<td>9%</td>
<td>10.1%</td>
<td>6.5%</td>
</tr>
<tr>
<td>Awareness of health benefits of active travel</td>
<td>99%</td>
<td>99.6%</td>
<td>99.6%</td>
</tr>
<tr>
<td>Participants having access to a car and who reduced car trips</td>
<td>107</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Participants walking (at least once a day)</td>
<td>54.9%</td>
<td>54.2%</td>
<td>68.8%</td>
</tr>
</tbody>
</table>
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.
The headline indicators of the impact of the Act measured in 2016 are summarized below:

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Figures 2016</th>
<th>Figures 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>The proportion of the population (aged 16 and over) who use a bicycle</td>
<td>5%</td>
<td>6%</td>
</tr>
<tr>
<td>for active travel at least once or twice a week</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The proportion of the population (aged 16 and over) who walk for active</td>
<td>61%</td>
<td>58%</td>
</tr>
<tr>
<td>travel purposes at least once or twice a week</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The proportion of the population (aged 16 and over) who use a bicycle for</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>active travel purposes at least three times a week</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The proportion of the population (aged 16 and over) who walk for active</td>
<td>47%</td>
<td>-</td>
</tr>
<tr>
<td>travel purposes at least three times a week</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The proportion of primary school children who typically walk or cycle to</td>
<td>43%</td>
<td>-</td>
</tr>
<tr>
<td>school.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The proportion of secondary school children who typically walk or cycle</td>
<td>35%</td>
<td>-</td>
</tr>
<tr>
<td>to school.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The number of seriously injured road pedal cyclists admitted to hospital.</td>
<td>236</td>
<td>225</td>
</tr>
</tbody>
</table>

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.

*Figure 5.17. Other examples from the Healthy Vision Green Structure Utrecht 2030 (March 2018)*

Streets in London, developed by Transport for London, 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. It could be a source of inspiration for cities in other parts of the world.

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134 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.

Chapter 6. Information Technologies and Intelligent Transport Systems (ITS)
Chapter 6. Information Technologies and Intelligent Transport Systems (ITS)

6.1 Continuous digital disruptions: where are we now with mobility and transportation?

6.1.1 Back in 2012

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 the 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 (roboats), in the air (drones)
- the development of Industry 4.0

The impacts of the ongoing 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.

6.1.2 Do our societies like mass transit?

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 the use of single-car ownership and driving. There are many ways to do so, such as imposing high congestion charges, eliminating public parking bays, narrowing the streets or promote integrated mobility solutions such as through the new concept of Maas of Mobility as a service. In principle, less cars in cities will 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. Paris, which has low car use, has 150 000 parking bays at street level that could be repurposed into lanes for new mobility. 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.

When dealing with ITC/ITS another factor needs to be taken in to 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 this summer at a valuation of $120 billion which would be an excellent result for its VCs. 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 The rise of CCTV monitored traffic and e-tolling

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 Indonesia show that the management of political and social factors are as important as the initial technological inputs.

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 previous years, in spite of an increase of vehicles per capita is increasing of %4,5 every year. As illustrated in 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 etc. 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.
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.

In Central Asia’s largest city, Tashkent, which counts 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.

6.3 Transport in the era of (big) data

6.3.1 From centralized to open-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 nished, 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).

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.

Figures 6.3 -6.4. From activism to integrated data: cycling as part of mobility systems in Flanders (Belgium) and in Kiev (Ukraine)

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 hel 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-de ned schedule.

6.3.2 The formation of open-data universal 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 of cial 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 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.

Figure 6.5 Principles of collecting open-data in the field of mobility

<table>
<thead>
<tr>
<th>Transport Instrument</th>
<th>Traditional Method</th>
<th>Open Transport Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>GIS Route and Station/Stop Locations</td>
<td>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</td>
<td>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</td>
</tr>
<tr>
<td>Passenger Volumes by Location and Time of Day</td>
<td>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</td>
<td>Survey staff can record boardings and alightings along entire route using mobile app. Data is saved with route information and automatically updated</td>
</tr>
<tr>
<td>Average Travel and Dwell Times</td>
<td>Staff ride transit routes and measure travel time between predetermined points on route map Travel time data manually entered on each route segment</td>
<td>Travel time automatically recorded and linked to route le</td>
</tr>
</tbody>
</table>

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.

136 Source: World Bank Open Transport Team
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.

Figure 6.6 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 sub-ject 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, trade-mark or trade secret regulation.

6.3.3 Mobility as a Service (MaaS): the development of consumer centric, data powered transportation models

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. 137

In municipalities, MaaS creates a wide range of services for users and thus offer an alternative

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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 flexible 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 flexible 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.

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.

Figure 6.6 The Maas Ecosystem

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.

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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.

![Figure 6.7 The “Whim” MaaS platform in Helsinki (Finland): a forerunner](image)

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.

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 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.
6.3.4 The next digital frontiers of mobility

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.¹³⁹

These technologies 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 filed 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

6.4 Smart traffic-lights

6.4.1 Smart traffic lights, smooth traffic flows?

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.

Figure 6.10 Smart traffic-light in Vienna, a rolemodel 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.

6.4.2 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.

Figure 6.11 Münster adaptive signal control system, a benchmark in Germany 141

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.

6.4.3 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 oor vehicles as passengers can enter and exit quickly. Innovative technology also enables dynamic

141 Source of the illustration. Siemens
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 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 criteria 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.

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.

6.4.4 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 centrope region connecting Austria, the Czech Republic, Hungary and Slovakia. The centrope 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:
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 Centre region step by step. The long-term goal is to expand a service in analogy to AnachB.at across the Centre 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.

6.4.5 Smart traffic 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.

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.

6.4.6 Simulation and evaluation: rethinking long term impact of mobility systems on livability and health

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.

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.

142 Source of the illustration: IFSTTAR
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 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 Comprehensive Intelligent Transport Systems (ITS)

#### 6.5.1 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

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143 Source:
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 Intelligent 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.

6.5.2 Fifty shades of smarter transportation

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 transporta 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 roadnetwork 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.
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.

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.

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). Travellers’ information systems are in use and should be improved and upgraded in an economically reasonable and moderate frame. Simple but efficient panels and screens are regarded as sufficient; an oversupply of electronic devices in vehicles, at stations and bus stops will increase fares and should be kept at a moderate level.

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144 Based on the answers given by the Republic of Belarus to the UNECE questionnaire.
145 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.
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.

Timetables display information about the number of vehicles en route, the final destination station and the estimated time of arrival at a particular station.

At the same time, data on the location of vehicles en route is transmitted to the mobile applications of the Moscow Transport System. Mobile applications display vehicle traffic based on navigation data obtained from on-board equipment via mobile cellular network.

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), Odnolassniki (ok.ru).146

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.147

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.148

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146 According to the response of Moscow (Russia) to the UNECE questionnaire.
147 http://transport.mos.ru, Unified Transport Portal of Moscow (Russia).
148 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
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.

**Figure 6.20-24 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 2020/5)
- **Amsterdam metro area** smart mobility system includes train, bus, roads
- **London Crossrail** «Elizabeth Line» (scheduled to operate by 2020)
6.5.3 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.)

Figure 6.25 Switzerland’s first experimental real scale driverless bus will run until 2019 in the city of Sion (Valais region)\textsuperscript{149}

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 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.

Autonomous vehicles, also known as driverless cars, automated cars or self-driving vehicles, can drive with minimal or no direct human intervention. One of the widely-accepted definitions of autonomous vehicles is: "Vehicles which move without the direct intervention of the driver in managing the processes of control, acceleration and braking and which are designed in such a way that when driving autonomously these vehicles do not require the driver to be keep an eye the road at all times"\textsuperscript{150}.

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 promptly and properly. 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

\textsuperscript{149} 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, 76% in the United States, 77% in India and 75% in Japan.

\textsuperscript{150} Center for Advanced Automotive Technology, “Connected and automated vehicles.”
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.

Figure 6.26 Example of an autonomous mobility structure

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 (see illustrations below). 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.

6.27 Examples of road safety and traffic fluidity enhancement through the use of autonomous vehicles (source?)

Figure 6.28 Development and prototyping of traffic management models based on technical systems and services of autonomous transport systems
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 it ground, air (drones) but also water. Amsterdam AMS has been a forerunner in researching how automated boats could serve a series of purpose 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.

Figure 6.29 The prototyping of “robaots” experiment in Amsterdam, a global cooperation 151

151 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

To be developed
Chapter 8. Conclusions and recommendations

To be developed
ANNEX
## Annexes to Chapter 1

### Annex 1.1 Urban demographics (% of total pop.) in UNECE countries (1950-2050)\(^{152}\)

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Annex 1.2 Principles of the distribution of street space between traffic users

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. 2nd PEP policy framework steering committee
- 2009. Amsterdam Declaration. 3rd PEP policy framework steering committee
- 2014. Paris Declaration. 4th PEP policy framework steering committee
- 2019. 22-24 October, Vienna (Austria). 5th PEP policy framework steering committee

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153 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

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<td>Rimini, Italy</td>
<td>2018</td>
<td>Active mobility - Making the change towards a green and healthy urban transport environment</td>
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<tr>
<td>Saint Petersburg, Russia</td>
<td>2018</td>
<td>Introduction of innovative green and healthy technical and technological solutions in road and urban passenger transport: global trends and opportunities</td>
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<tr>
<td>Mannheim, Germany</td>
<td>2017</td>
<td>Cycling and Walking</td>
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<tr>
<td>Vladivostok, Russian Federation</td>
<td>2016</td>
<td>Sustainable transport planning in big cities</td>
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<tr>
<td>Vienna, Austria</td>
<td>2016</td>
<td>Decarbonization — Zero emission mobility starts now!</td>
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<td>Petrozavodsk, Russian Federation</td>
<td>2016</td>
<td>Burdens and benefits of motorized and non-motorized transport</td>
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<td>Irkutsk, Russian Federation</td>
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<td>Integrating Transport, Urban Planning and Traffic Management</td>
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<td>Kaunas, Lithuania</td>
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<td>Sustainable Mobility for Better Health and Environment</td>
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<td>Almaty, Kazakhstan</td>
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<td>Sustainable Mobility: Focus on Urban Central Asia</td>
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<td>Moscow, Russian Federation</td>
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<td>Sustainable Development of Urban Transport</td>
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<td>Kyiv, Ukraine</td>
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<td>Working together for sustainable and healthy urban transport</td>
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<td>Batumi, Georgia</td>
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<td>Safe and healthy walking and cycling in urban areas</td>
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<td>Pruhonice-Prague, Czech Republic</td>
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<td>Skopje, FYROM</td>
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<td>Sustainable urban transport policies in south-east Europe</td>
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<td>Chisinau, Moldova</td>
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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**

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<th>Activity area</th>
<th>Practice of successful cities</th>
<th>Measures to build and develop sustainable urban transport systems</th>
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<tr>
<td><strong>Strategic planning and development of sustainable transport systems integrated with urban policy and urban planning</strong></td>
<td>Availability of strategic planning and development of sustainable transport systems integrated with urban policy and urban planning. Tools to limit the demand for private car use in areas of urban development. A mechanism introduced to prioritise efficiency projects (geared at minimising costs, damage from environmental pollution and the number of accidents per passenger transported).</td>
<td>Formulation of a strategy for the development of sustainable transport systems. Formulation of Sustainable Urban Mobility Plans. Integration of spatial and urban planning legislation with transport planning strategic documents.</td>
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<tr>
<td><strong>Financing</strong></td>
<td>Predictable financial resources, efficient budget allocation, long-term planning.</td>
<td>Improving long-term budget sustainability and predictable planning and allocation of financial resources. Targeted financial support for sustainable urban transport activities. Identification of priority areas for expenditures.</td>
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154 Developed by the UNECE consultant Rimma Filippova, 2019.
<table>
<thead>
<tr>
<th>Activity area</th>
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<th>Measures to build and develop sustainable urban transport systems</th>
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<td></td>
<td>ticket (universal fare system), informing passengers in real time, route landmarks, convenient routes and schedule.</td>
<td>Prioritising the movement of route vehicles, 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.</td>
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<tr>
<td>Road and street network</td>
<td>The road and street network should develop aligned with the needs and at the necessary scale. Clear priorities for investments into the development of road and street networks. Application of advanced techniques in equipping and maintaining roadways. Building street and road networks in adherence to the “Livable City” goal.</td>
<td>Regular roadway surveys. Vigorous implementation of automated traffic control systems in cities. Implementation of innovative “environmentally friendly and sound” technical and technological solutions.</td>
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<td>Road traffic management</td>
<td>Ensuring a balance between the transport demand of the population and the functionality of sustainable urban transport systems.</td>
<td>Integration and reinforcement of engagement between authorities and providers. Introduction of advanced technologies in road traffic management. Use of new information and organisational technologies. Application of ITS. Enhancing design quality in road traffic management.</td>
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<td>Reducing regular congestion affecting urban road and street networks</td>
<td>Taking measures to achieve a reasonable restriction of movement of privately owned vehicles, imposing restrictive measures to limit the traffic of freight vehicles.</td>
<td>Imposition of restrictive measures on privately owned vehicles as well as on the traffic of freight vehicles. Ensuring the required laws and regulations; introduction of amendments to the legislation currently in force.</td>
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<tr>
<td>Organisation of urban parking space</td>
<td>Pursuing comprehensive approaches to the organization of single urban parking space. Enforce measures to restrict the traffic of privately owned vehicles within reasonable limits.</td>
<td>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.</td>
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<td>Safety management</td>
<td>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.</td>
<td>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.).</td>
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<tr>
<td>Environmental protection and mitigating the impact of motorised transport on climate change and public health</td>
<td>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.</td>
<td>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.</td>
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<td>Comfortable urban environment and “living green” streets</td>
<td>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.</td>
<td>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.</td>
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<tr>
<td>Support and develop non-motorised modes of transport</td>
<td>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</td>
<td>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</td>
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<tr>
<td>Activity area</td>
<td>Practice of successful cities</td>
<td>Measures to build and develop sustainable urban transport systems</td>
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<td>Approach&quot; and the &quot;Vision Zero&quot; approach. Apply incentives to promote the use of non-motorised modes of transport and travel. Promote mobility through the mutual integration of public transport, cycling and car sharing.</td>
<td>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.</td>
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<tr>
<td>Enhance energy efficiency and energy saving in the road transport sector</td>
<td>Implement energy efficiency measures in the transport sector to save significant amounts of energy; support and promote the introduction and advancement of &quot;clean&quot; technologies and motorised vehicles (such as LRT, trams, trolleybuses, electric buses, electric vehicles, hybrid electric vehicles).</td>
<td>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 &quot;environmentally friendly&quot; 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.</td>
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</table>
## Structure of the Wales travel Act

<table>
<thead>
<tr>
<th>Theme</th>
<th>Number</th>
<th>Action</th>
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</thead>
<tbody>
<tr>
<td><strong>Leadership</strong></td>
<td>1.</td>
<td>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</td>
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<tr>
<td></td>
<td>2.</td>
<td>National strategic oversight of delivery of the Active Travel Act and the Action Plan by The Active Travel Board.</td>
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<td></td>
<td>3.</td>
<td>The Welsh Government works closely with local authorities to communicate how active travel directly supports the well-being goals and benefits cross service delivery.</td>
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<td><strong>Legislation, Standards and Tools</strong></td>
<td>4.</td>
<td>Subordinate active travel legislation remains under review, learning from early implementation of the Active Travel Act.</td>
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<td>5.</td>
<td>Determine best approach to improving road safety in Wales for pedestrians and cyclists. Consider legislative opportunities for strengthening active travel.</td>
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<td>6.</td>
<td>We will keep the Design Guidance under review, building on feedback from local authorities on the use of different design elements.</td>
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<td>7.</td>
<td>The Active Travel Data Management System: capture, manage and publish information on active travel infrastructure in Wales. Provide public access to key information.</td>
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<td>8.</td>
<td>Incorporate the consideration of health impacts into a revised WeITAG.</td>
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<td>9.</td>
<td>Consider further updates to TAN 18: Transport and TAN 12: Design to further promote active travel through the planning system.</td>
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<td>10.</td>
<td>Encouragement of schools to raise awareness of the importance of active travel to the health and well-being of pupils.</td>
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<td></td>
<td>11.</td>
<td>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.</td>
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<td><strong>Infrastructure</strong></td>
<td>12.</td>
<td>Develop the strategy for funding active travel infrastructure investment.</td>
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<td>13.</td>
<td>Ensure provision for walkers and cyclists in terms of direct investments in transport infrastructure.</td>
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<td>14.</td>
<td>We will continue to make grant funding available for high quality local active travel schemes.</td>
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<td></td>
<td>15.</td>
<td>Require consideration of access for walkers and cyclists before supporting capital investments.</td>
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<td><strong>Promotion &amp; Behavior Change</strong></td>
<td>16.</td>
<td>Development of an active travel promotion and engagement toolkit.</td>
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<td>17.</td>
<td>Development of the national communication strategy for active travel.</td>
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<td>18.</td>
<td>Work with Traveline Cymru to explore the improvement and marketing their active travel journey planner.</td>
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<td>19.</td>
<td>The promotion of Active Travel in schools including pedestrian and cycle training. Encouragement of closer links between complementary school-based programs.</td>
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<td>20.</td>
<td>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.</td>
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<td>21.</td>
<td>Monitor conflict between transport user groups and identify measures to improve their interaction.</td>
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<td><strong>Skills &amp; Training</strong></td>
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<td>22.</td>
<td>Offer training on the use of the Design Guidance and enable interactive learning on other aspects of active travel.</td>
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<td>23.</td>
<td>Develop mechanisms to enable practitioners to share experience and provide feedback.</td>
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<td>24.</td>
<td>Seek out opportunities to raise awareness of the Act and its aims and requirements among transport, health and education professionals, and local councilors.</td>
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<td><strong>Monitoring &amp; Evaluation</strong></td>
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<td>25.</td>
<td>Develop active travel targets and work with local authorities to develop a consistent local monitoring and reporting framework.</td>
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<td>26.</td>
<td>Continue to require Welsh Government funded schemes the effective monitoring and evaluation.</td>
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<td>27.</td>
<td>Explore opportunities to enable and encourage sharing of monitoring and evaluation results.</td>
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<td>28.</td>
<td>The Action Plan will be monitored by the Active Travel Board on an on-going basis. Updates included in annual Reports.</td>
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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
UNECE HANDBOOK ON SUSTAINABLE TRANSPORT AND URBAN 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

Draft V2
April 12 2019